Railway Machinery.

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RAILWAY MACHINERY.

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September, 1906.

SUPERHEATING COMPOUND EXPRESS LOCOMOTIVE, BAVARIAN STATE RAILWAYS.

CHARLES R. KING.

Progress in locomotive design in Bavaria is so rapid and continuous that the builders there take the lead of all Europe, including even Austria—France now being the last of the stragglers. The latest development in the four-cylinder balanced compound locomotive is illustrated in the subjoined photographic reproduction. It has been specially designed for high speeds, to average about 95 miles per hour between stops, on the Muenchen to Nürnberg section of the Bavarian State Railways. The engine, of which several others are in construction, has not yet undergone its official trials, but the chief engineers of the celebrated J. A. Maffei Locomotive Works have shown in many previous examples that their locomotives can always exceed the stipulated output for power and speed. To attain this object a very large boiler with a great heating surface and flues with superheating pipes in the upper rows has been provided; and to carry this generator without exceeding the maximum limits of load in the driving wheels (35,200 pounds) an extra pair of wheels had to be introduced under the footplate, so making a four-connected engine with two bearing trucks which, with certain modifications, would permit the locomotive to run with either the smokebox or the firebox in front. The engine proper is a four-cylinder balanced compound of that Central European type which is rapidly displacing all other engine arrangements. All main rods drive the leading connected axle which is of the oblique-arm type with hollow crank seats. One valve gear actuates two out of the four valves. The valves are of the type described in the issue of May, 1906, page 437. The valves by which the live steam is introduced into the low-pressure cylinders, when starting, are, here, quite different. At each end of the low-pressure valve chests there are, at right angles to the diameter of the chambers, two cylindri-

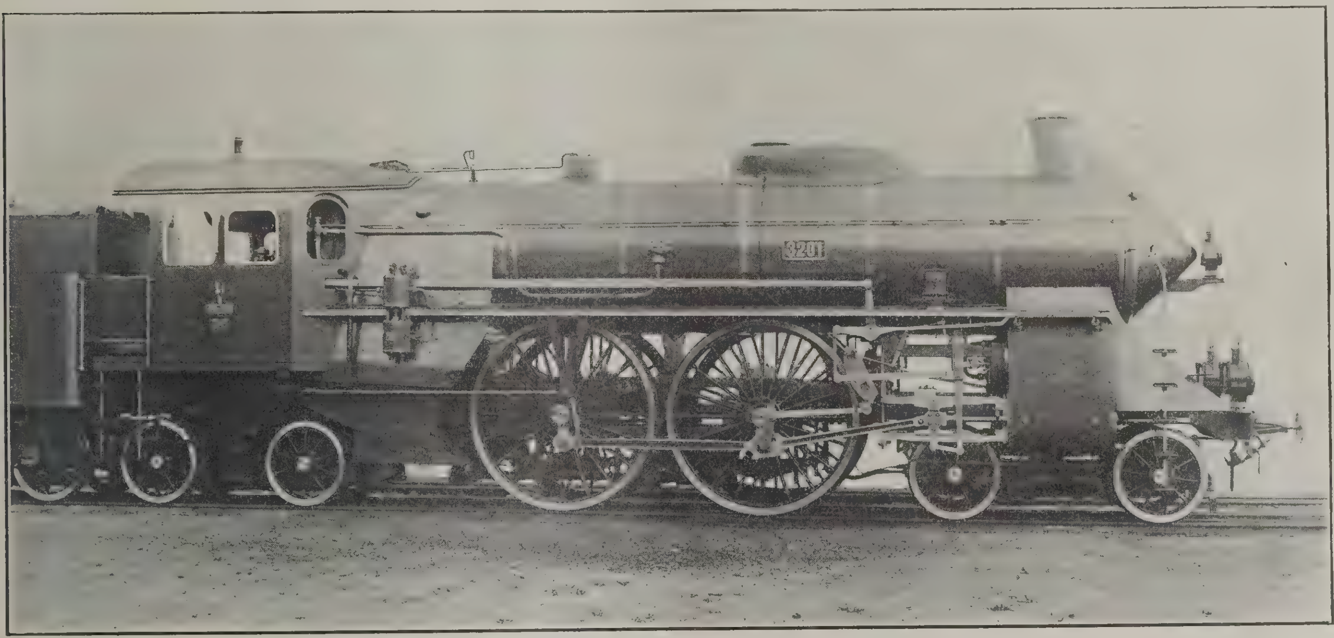

Fig. 1. Superheating Compound Express Locomotive, 4—4—4 Type, Bavarian State Railways.

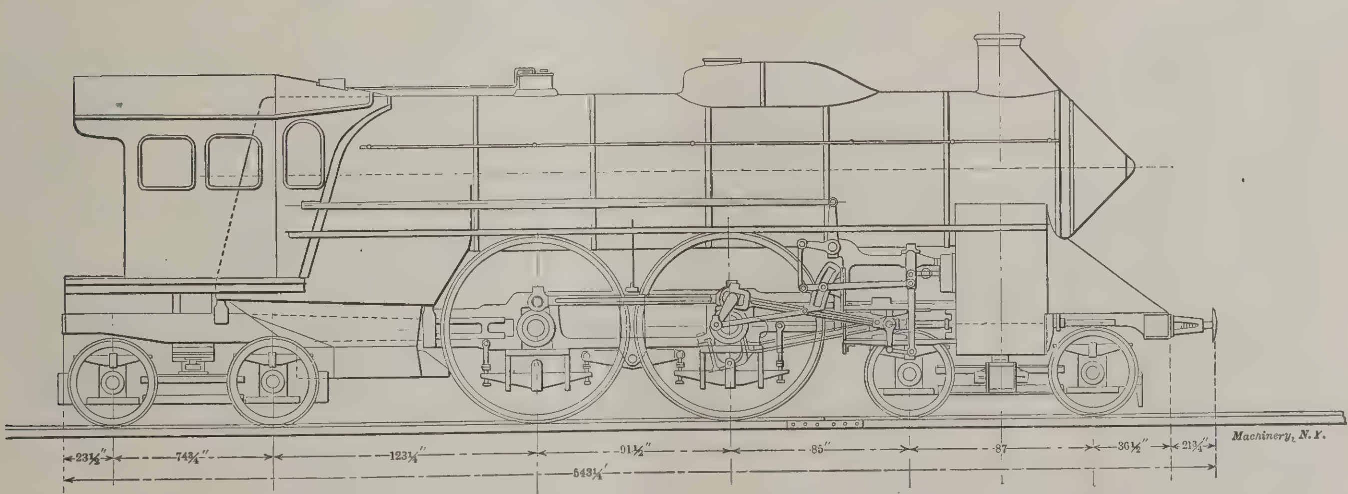

Fig. 2. Diagram showing Wheel Center Distances, Etc., 4—4—4 Superheating Compound Express Locomotive.

cal valves which when raised give entrance to the live steam whenever the valve travel exceeds a cut-off of 70 per cent of piston stroke. This movement is derived from a long rod connecting the valve stems with the reach-rod shaft and is therefore automatic in operation and independent of the locomotive engineer. There is also an attachment on the expansion link for working the oil pump, also visible in the engraving. The frames are of the bar type. All projections in the locomotive are cased in with plates shaped so as to cut or divide the air when the machine is traveling at high velocities. The cylinders, smokebox, chimney, the dome and sand box (ranged together) and the entire cab front, have been curved up or shaped with this object, the saving of power thereby effected meaning increased speed. The proportions of the main rods and side rods have been calculated for the maximum of tractive effort, which is 5 tons, while the total adhesive weight is 32 tons with engine loaded, a coefficient of 1:6.4. The engine is not designed for great tractive power, but to make a speed of 94 miles per hour with a trainload of 180 metric tons. The metric ton is about 10 per cent more than the U. S. ton and the traction effort is calculated according to Continental formula which gives very much lower values than the American formulas. The weights of the engine in the following list are the correct ones; those published by some Continental journals relate, presumably, to the estimated weights in the original project for the new engines.

SUPERHEATING COMPOUND BALANCED LOCOMOTIVE.

Type C 2/6 Bavarian State Railways.

H. P. cylinders	16⅛ inches.
L. P. cylinders	24 inches.
Stroke	25¼ inches.
Boiler pressure	205.8 pounds.
Driving wheels diameter	7 feet 2⅝ inches.
Tractive effort (effective)	10,400 pounds.
Diameter of front and back truck wheels	3 feet 3½ inches.
Boiler (inside diameter)	5 feet 7 inches.
No. of tubes	208
Tubes, diameter (inside)	0 feet 2 inches.
No. of flues enveloping superheat pipes	18
Flues, diameter (inside)	0 feet 5 inches.
Total free length of tubes	16 feet 1 inch.
Heating surfaces (inside measurement):	
Small tubes	2,130.5 square feet.
Large flues	409 square feet.
Firebox	177.5 square feet.
Total	2717.0 square feet.
Grate area	50.0 square feet.
Weights:	
Engine, empty	167,200 pounds.
Engine, fully loaded	184,800 pounds.
Weight distribution:	
Drivers	70,400
Front truck	62,700
Rear truck	51,700
Total	184,800
Gage	4 feet 8½ inches.
Minimum radius of curves	600 feet.
Rigid wheel base of engine	7 feet 7⅜ inches.
Total wheel base of engine	38 feet 4½ inches.
Total length of engine	45 feet 2 inches.
Greatest breadth of engine	10 feet 2 inches.
Greatest height of engine	15 feet.
Height of boiler center	9 feet 10 inches.

Tender.

Rigid wheel base	5 feet 8⅞ inches.
Total wheel base	17 feet 4⅝ inches.
Total length of tender	24 feet 2 inches.
Greatest width	10 feet
Wheels, diameter	3 feet 3½ inches.
Water capacity	5,730 gallons.
Coal capacity	8.8 U. S. tons.
Weight, empty	41,800 pounds.
Weight, loaded	114,400 pounds.
Total wheel base of engine and tender,	60 feet 7½ inches.
Total length of engine or tender	69 feet 4 inches.
Weights:	
Engine and tender empty	104 U. S. tons.
Engine and tender fully loaded	149 U. S. tons.

* * *

It is claimed that the Baldwin Locomotive Works would, by itself, support a city of 100,000 inhabitants.

NEW NORTHERN PACIFIC RAILWAY LOCOMOTIVES.

The American Locomotive Company has recently completed twenty Pacific type locomotives for the Northern Pacific Railroad. They are identical in design with the Class Q—1 engines built by this company for that road, except in the design of the boilers.

The boilers of both classes are radial-stayed, extended wagon-top type with the same size firebox and the same outside diameter at the front and back and the same length over all. Both boilers have 2-inch tubes spaced 2⅞ inches centers, at the front end in the boiler shown, and 2 29-32 inches centers at the front end in the boiler of Class Q—1. The boilers of the engines illustrated, however, are designed with a combustion chamber. The combustion chamber is 3 feet long and the tubes are 16 feet 9 inches long. In the Class Q—1 engines without combustion chambers the tubes are 18 feet 6 inches long; or, in other words, the combustion chamber cuts off 1 foot 9 inches in the length of the tubes. In addition to being shorter, the number of tubes in this boiler is also less than in the boiler of the Class Q—1, there being 306 tubes in the one as against 347 in the other.

The tube heating surface and total heating surface are, accordingly, much less in these later engines than in those without combustion chamber, while the firebox heating surface is much greater. The comparative heating surfaces are as follows:

	With Combustion Chamber.	Without Combustion Chamber.
Tube heating surface	2,737 sq. ft.	3,339 sq. ft.
Firebox heating surface	233 sq. ft.	182 sq. ft.
Arch-tube heating surface	9 sq. ft.	7 sq. ft.
Total heating surface	2,979 sq. ft.	3,528 sq. ft.

From this comparison it will be seen that the tube-heating surface has been reduced 602 square feet, or 18 per cent, and the total heating surface 550 square feet, or about 15.6 per cent, while the firebox heating surface has been increased 51 square feet, or about 28 per cent.

It will be interesting, also, to compare the ratios of tube heating surface and total heating surface to the volume of one cylinder in the two classes of engines, both having the same size cylinders:

Tube heating surface divided by volume of one cylinder: With combustion chamber = 478; without combustion chamber = 583.

Total heating surface divided by volume of one cylinder: With combustion chamber = 520; without combustion chamber = 616.

These ratios are lower in the engine with the combustion chamber and higher in the engine without than are generally found in the Pacific type locomotive, the average ratio of tube-heating surface to cylinder volume in this type being about 525, and of total heating surface to cylinder volume 550.

Whereas it might at first appear that this great reduction in heating surface was rather a venturesome experiment, particularly in this type of engine in which large boiler capacity is so essential, this design of boiler is no new experiment on the Northern Pacific. Mr. D. Van Alstyne, mechanical superintendent of the Northern Pacific, has made a very careful study of locomotive boiler design, and, as a result, in 1904 one of twenty tandem compounds built by this company for the Northern Pacific at that time was fitted with a combustion chamber and its record, under the severest tests in service on divisions where the water conditions were the worst, has been most satisfactory. The application of a boiler with combustion chamber to the Pacific type, therefore, is only a further development along the same lines.

The combustion chamber in the Pacific type is supported by expansion stays, radial stays, staybolts and bottom braces. The water space at the bottom is 7½ inches, and 7 inches at the side, giving good water circulation with no danger of the combustion chamber being overheated. In these engines the front tube sheet was moved 15 inches further ahead than it is in the Pacific engines without combustion chambers. This was done to avoid reducing the length of the flues by the full

length of the combustion chamber as the number of tubes had also been reduced.

Though the tube heating surface is greatly reduced by the combustion chamber, the firebox heating surface is greatly increased, and, in the case of the Mikado type (described below) this increase in the firebox heating surface seems to more than offset the loss of the tube heating surface and to give an engine with just as good steaming qualities.

The advantages and disadvantages of the boiler with combustion chamber have already been thoroughly discussed in various papers on the subject and the merits of this design ably presented so that it is useless for us to elaborate on them in this description.

These engines, however, afford a good opportunity for judging of the comparative merits of the two designs of boiler and the record of these engines with combustion chambers as compared with those of the same design running on the same road and under the same conditions, but with boilers without combustion chambers will be of great interest to railroad officials and the technical world.

What will add further interest to the Pacific type locomotives is that the twentieth engine of this lot is equipped with the latest design of the Schenectady superheater which is attracting a great deal of attention among railroad men in this country at the present time.

The combustion chamber and superheater are among the most recent developments in locomotive design and the Northern Pacific officials, and the whole railroad world as well, will have an opportunity such as they do not often enjoy to watch the performance of the three different exponents of recent locomotive construction—the simple engine with long flues, the simple engine with short flues and combustion chamber, and the simple engine with combustion chamber and superheater, all three engines being identical in design except for the special features of combustion chamber and superheater.

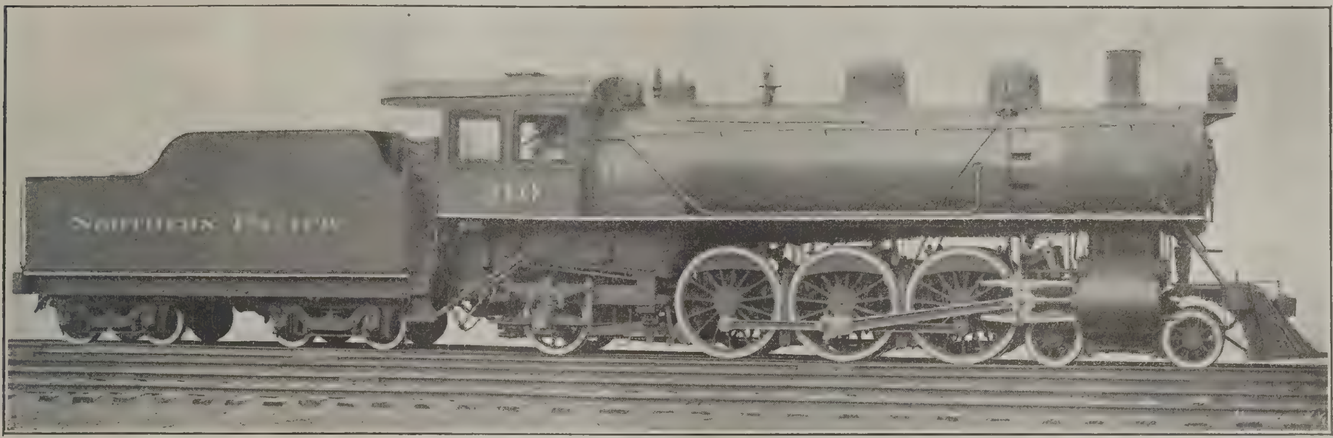

Fig 1. Northern Pacific Railroad Pacific or 4—6—2 Type Locomotive. Cylinders 22x26.

Fig. 2. Northern Pacific Railroad Mikado or 2—8—2 Type Locomotive. Cylinders 24x30.

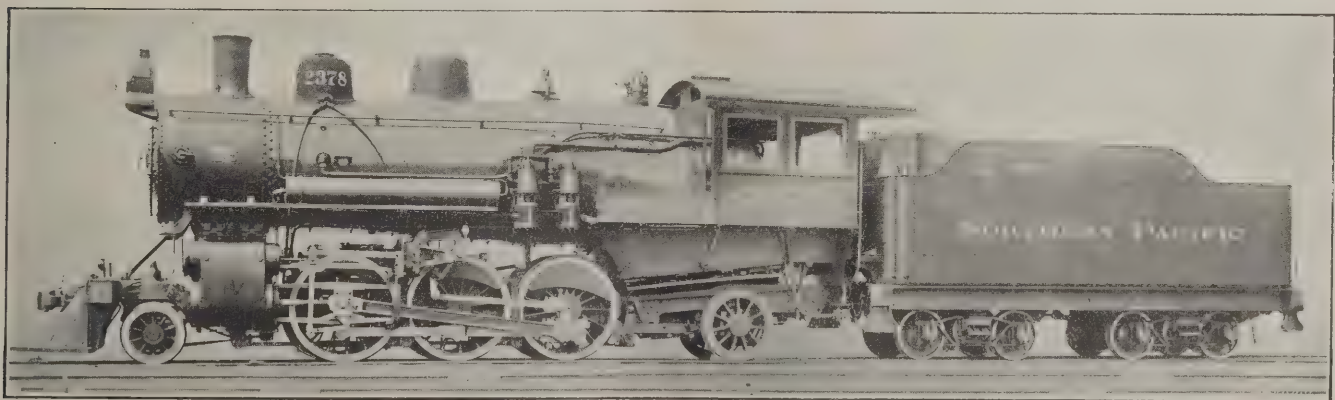

Fig. 3. Northern Pacific Railroad Prairie or 2—6—2 Type Locomotive. Cylinders 21x28.

Mikado Type.

The same course as in the case of the Pacific type has been followed in the thirty Mikado type engines, a halftone of which is here given. These engines are identical in design with the Class W simple engines built by this company for the Northern Pacific in 1904 and 1905, except for the special feature of the combustion chamber. In the Mikado type, however (as was not the case in the Pacific type locomotives), the boiler with combustion chamber contains the same number of tubes as that without combustion chamber, while the

length of the tubes has been shortened by the full length of the combustion chamber. This reduces the total heating surface by 14.2 per cent. The comparative heating surfaces of the two classes of the Mikado type are as follows:

	Without Combustion Chamber.	Without Combustion Chamber.
Tube heating surface........	3,192 sq. ft.	3,798 sq. ft.
Firebox heating surface......	234 sq. ft.	200 sq. ft.
Arch-tube heating surface.....	11 sq. ft.	9 sq. ft.
Total heating surface.....	3,437 sq. ft.	4,007 sq. ft.

The combustion chamber has already been tried with great success in this design—the tandem compound Mikado type engines, to which we have already referred as having had this type of boiler, being of the same design as Class W except with compound cylinders. Though, as we have before stated, we do not care to discuss at length the merits of the combustion chamber, it will not be out of place right here to give a few extracts from Mr. Van Alstyne's paper, "Some of the Essentials in Locomotive Boiler Design," presented before the North-West Railway Club. He says: "What seems to me an especially good feature of the combustion chamber, if it is practical, is the fact that it very materially increases the heating surface of the firebox"; again: "The beauty of the combustion chamber is in getting the flues away from the fire," and later, "The great convenience and economy that is derived from this combustion chamber" (referring to the Mikado engine which we have already mentioned) "is due to the fact that the flues can be worked without disturbing the brick arch.

A report of the condition of the boiler of this engine after an inspection made by Mr. Van Alstyne immediately after the engine had been cooled off seems to justify his claims as to the advantages of the combustion chamber.

The brick arch was in place, the flues showed very little indication of leaking or having had any work done on them, the combustion chamber showed no signs of overheating and was free from ashes, and the bottom flues were open and not choked.

Only one engine failure from leaky tubes was reported against this engine during its years service on the Yellowstone Division, and this, where the water conditions are notoriously bad and Mr. Van Alstyne says that he believes that they were doing only about 25 per cent as much flue expanding on her as on the other engines on the same division.

This engine has since been sent to the Montana Division.

Prairie Type.

The Prairie type illustrated and described here is the first of this type of locomotive to be built for the Northern Pacific. This type has proven so satisfactory on other roads that they ordered twenty of this company, which were completed last May.

These engines are also equipped with boilers having combustion chambers. The combustion chamber of this type is 4 inches shorter than the other two types described, and the tubes are some 3 feet shorter. These differences, however, are due solely to differences in the types of the engines.

One of each lot of both the Mikado and Prairie types is equipped with Walschaert valve gear, and the halftones of these types show the engines having this valve gear.

How much faith the Northern Pacific has in the locomotive boiler with combustion chamber, and what a satisfactory type of boiler they consider it, is shown by the number of engines—70 in all—that they have ordered with boilers of this design.

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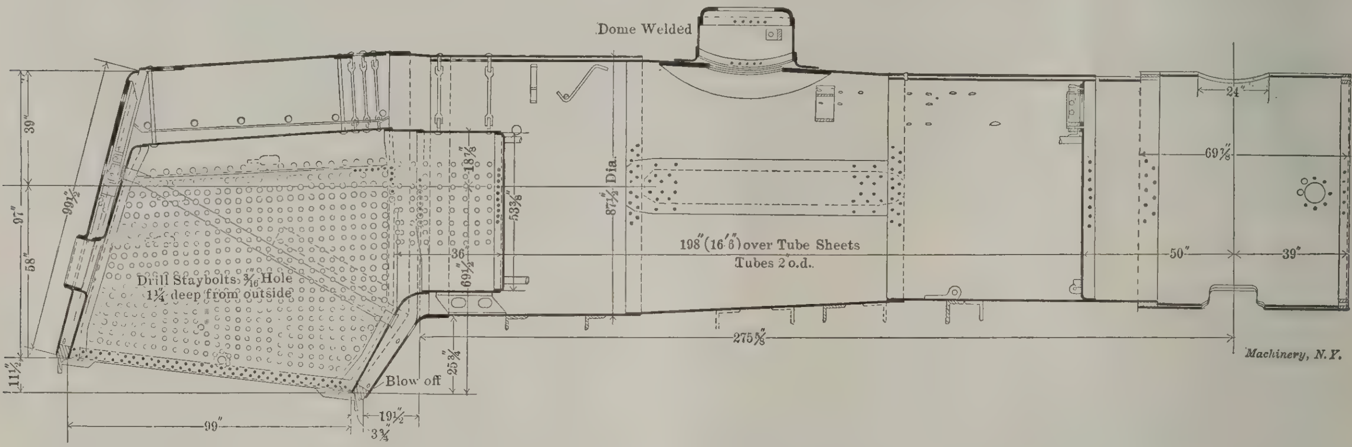


Fig. 4. Longitudinal Section of Boiler for Mikado or 2—8—2 Type Northern Pacific Railroad Locomotive.

NOMENCLATURE OF WALSCHAERTS VALVE GEAR.

CHARLES R. KING.

The terms used to denominate the component parts of the Walschaerts valve gear have, in the United States, since its introduction here, undergone changes which, though they may be handy in shop routine, are not very exact, while they might eventually prove to be untranslatable in technical dictionaries.

In the Walschaerts valve gear the mechanism is so simple that, after a lapse of fifty years, there is no necessity now to complicate matters by the introduction of wonderful terms for describing the parts, as "kicker," etc. We have, first, a simple crank describing a true circle: 1, "valve crank," and a rod connecting it with the radius link; 2, "valve-crank rod." This arrangement gives only a valve motion corresponding with the driving crank periods. Hence, "lead" is given by means of a lever; 3, "lead lever," which pivots on the radius rod (below the valve stem for outside admission and above the valve stem for inside admission with ordinary piston valves). The tip end of the lead lever is connected, as the case may require, with the valve stem or otherwise with the radius rod, and its lowest extremity is connected, as closely

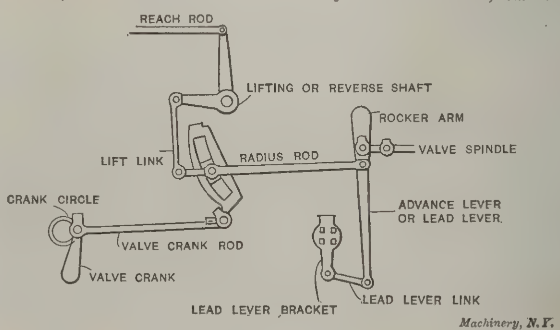


Diagram Illustrating Parts of the Walschaerts Valve Gear.

as can be done, to the piston crosshead. This involves a link: 4, "lead-lever link" and a bracket: 5, "lead-lever bracket" for attachment to the crosshead. This latter should be made as short as possible consistent with the length required for the lead lever. In the ideal arrangement the center of the crosshead should be the center also of the rear pin of the lead-lever link in order to increase the rigidity of the lead-lever drive. All the foregoing terms are perfectly accurate in their descriptiveness, and, if translated literally, have the same significance in all Latin languages, and without ambiguity. The terms originally employed for the Walschaerts valve gear were French, for, although this name is Flemish, French is the scientific language of the Belgians. The object of these remarks is, it will be evident, to favor a classic and universal

engineering language, in place of shop jargon which, only too often, is the basis for our industrial vocabulary, and to show that the Walschaerts valve gear parts, at least, are not in need of being christened anew after half a century of regular use.

* * *

SIDE PLAY OF TRUCKS ON CURVES, AND METHOD OF CALCULATION.

In the July issue of Railway Machinery the writer noted an article on "Side Play of Trucks on Curves, and Method of Calculation." The article in question gives formulas and indicates the derivation of the same, together with a table showing side play required for rigid wheel bases up to 15 feet for various curve radii.

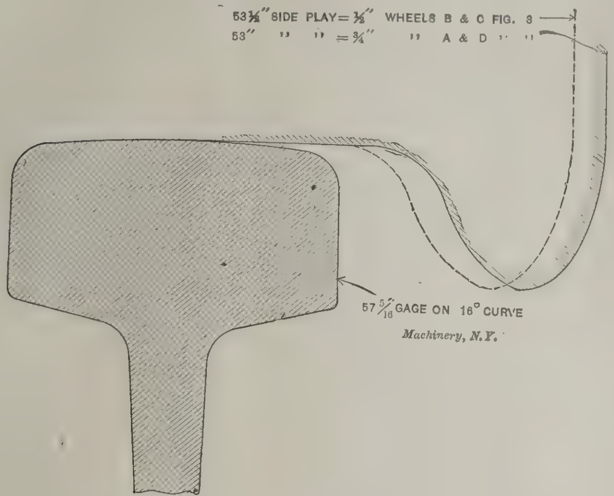


Fig. 1. Showing Side Play of Wheel Flange and Rail Head.

The writer quotes from the findings of Mr. A. M. Wellington, to the effect that "a rigid truck, in passing a curve, whether alone, or coupled with another, takes the position with the rear axle, approximately radial, as indicated in Fig. 2"; said Fig. 2 showing the front wheel pressing against the outer rail, and the rear wheel pressing against the inner rail. The figures given for side play for the different curves and wheel bases, are evidently based upon the assumption that the rear axle of any rigid wheel base is literally radial to the curve with the result that requirements for side play are obtained which are impossible to provide for in most cases.

From an extended experience in locomotive design, with both railroads and locomotive building plants, the writer of the present article takes exception to the article in July issue, not in a spirit of carping criticism, but rather to bring out more fully for the benefit of readers of Railway Machinery, a subject about which but little has so far apparently been published.

That the rear wheel of a rigid truck will press against the inside rail of a curve, and the forward wheel will press against the outer rail, is a correct statement, but that the rear axle assumes a position approximately radial to the curve, is a statement which actual practice does not seem to warrant.

As an example of actual practice on the P. & R. Ry, Fig. 5 shows the wheel-base of a four-wheel switching engine. The wheel-base W is 69 inches, and the engine passes around a curve of 60-foot radius. The tires on this engine are set 53¼ inches between flanges and a box play of $\frac{1}{16}$ inch on each side is allowed. The gage of track on this curve is 57¼ inches, or ¾ inch wider than standard; but if the rear axle is assumed to be radial to curve, as shown in Fig. 4, a side play of 3.3 inches would have to be provided for, which is the measure of P, or versed sine of an arc of 60 feet radius and 69 inches taken as half the chord of arc.

However, the actual side play of this engine on 57¼ inch gage is only a total of 1 5-16 inch made up as follows: (See Fig. 5.) Front wheel $A = 19\text{-}32$ inch play between the flange of wheel and rail head, plus 1-16 inch box play, all in direction of the outer rail. Rear wheel $B = 19\text{-}32$ inch play between the flange and rail head, plus 1-16 inch box play, all in direction of the inside rail. The total possible side movement being $(19\text{-}32 + 1\text{-}16) \times 2 = 1\ 5\text{-}16$ inch.

Placing the engine on a curve of 60-foot radius with the center of the curve falling on the center of the wheel-base, as in Fig. 5, the actual side play, or versed sine of arc $P = 1.2$

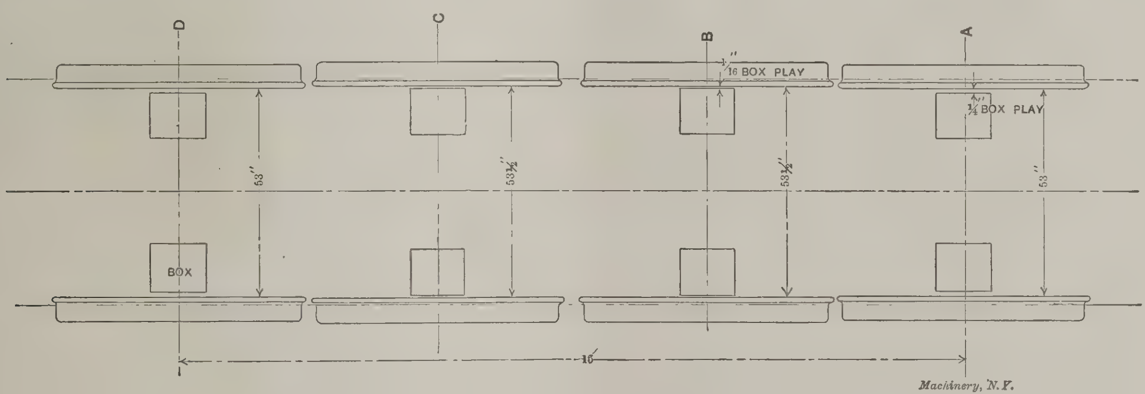


Fig. 2. Box Arrangement of P. & R. Railway Eight-driver Locomotive.

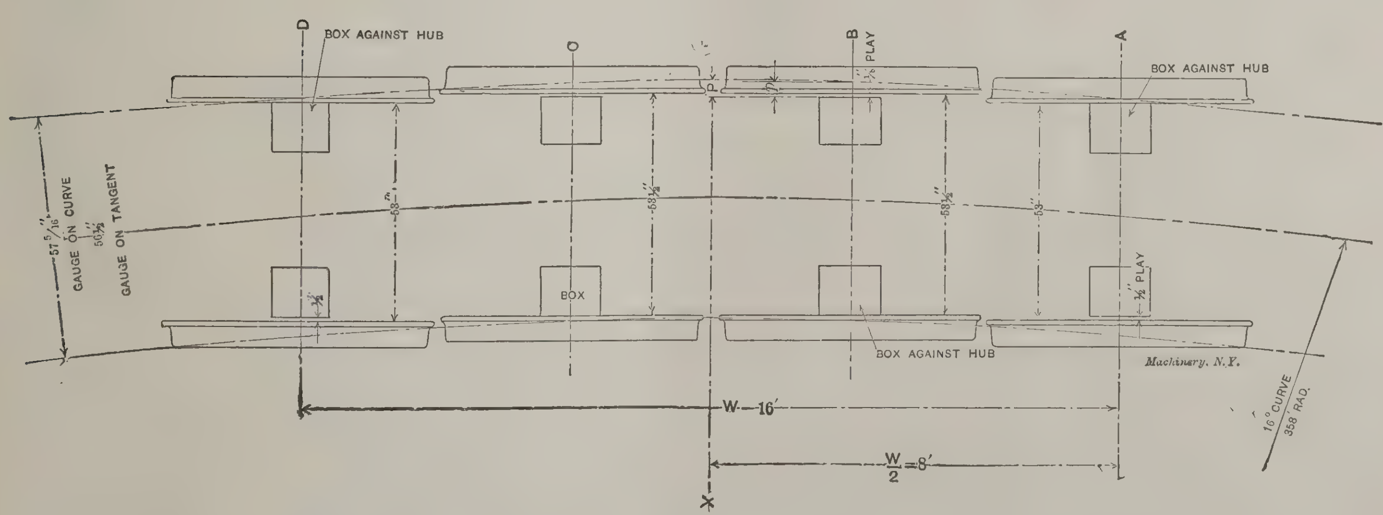


Fig. 3. Showing Position Assumed on Curve by P. & R. Railway Eight-driver Locomotive.

inches, thus showing that the engine will just pass the curve without any side play to spare.

This latter method is followed, I believe, by all builders in determining the curve an engine will pass.

On many of the standard railroads of the country the gage is widened ¼ inch for each 5 degrees of curvature with a maximum increase in gage width of ¾ inch for any curves on main line.

A considerable number of roads have consolidation locomotives (2-8-0) with 16-foot rigid wheel-bases, the wheel and box arrangement being as shown in Fig. 2. These engines

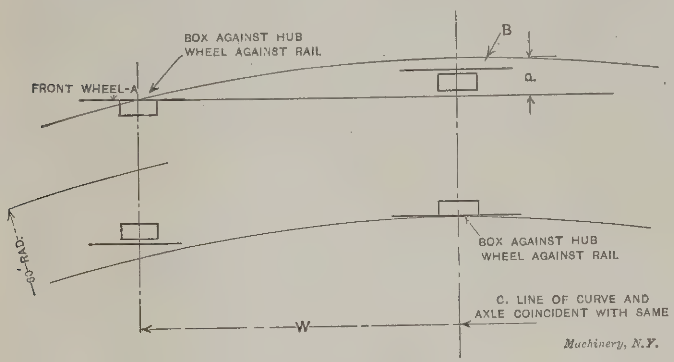


Fig. 4. Position Assumed by Four-wheel Locomotive if Rear Drivers remained Radial to the Curve.

pass 16-degree curves in daily service, without showing any track distress, or in other words, without moving the track out of its original alignment.

On the basis of ¼ inch increase in gage of track for each 5 degrees of curvature, the gage on a 16-degree curve would be $56\frac{1}{2} + (16/5 \times \frac{1}{4}) = 57.3$ inches, say $57\frac{5}{16}$ inches. Taking into account the side play of the wheel flange to rail head, as indicated in Fig. 1, and the side play between the axle boxes and wheel hubs, the total movement of the engine or side play would be only 1⅜ inch, as follows: (See Fig. 2.) For wheels *A* and *D*, the side play between the wheel flange and rail head = ¾ inch. The box play for the same wheels = ¼ inch; hence the total = ¾ + ¼ = 1 inch. For wheels *B* and *C* the play between wheel flange and rail head = ½ inch, and the box play = 1/16 inch, or a total of 9/16 inch.

The total engine side play on $57\frac{5}{16}$ inch gage track would, therefore, be 1 inch $+ \frac{9}{16} = 1\frac{9}{16}$ inch.

Taking the assumption that the forward wheel hugs the outer rail, and the rear wheel hugs the inside rail, and further that the rear axle is *radial* to the curve, as stated and

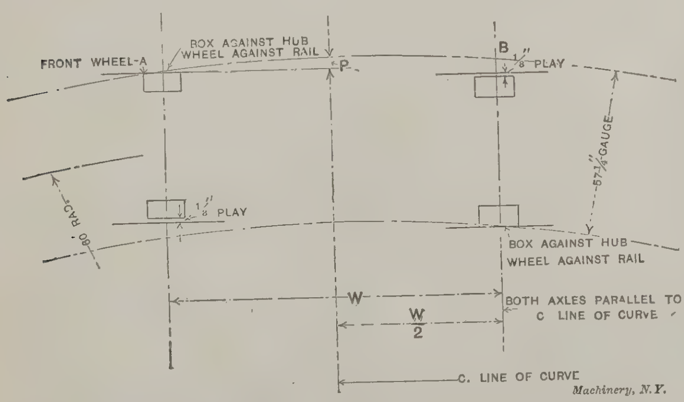


Fig. 5. Box Arrangement of P. & R. Railway Four-wheel Switching Locomotive.

assumed in the article in the July issue, the versed sine of the arc of a 16-degree curve, or 358 feet radius, with a 16-foot rigid wheel-base would be $R = \frac{W^2}{2P}$ or $358 = \frac{(16)^2}{2P}$; hence $2P = 256/358$ or $2P = 0.71$ foot. $P = 0.355$ foot, or 4.26 inches, which side play would have to be provided in wheel arrangement of engine and widening of gage.

That this amount of side play is not needed and that it cannot be found on any railroad operating 2-8-0 engines over 16-degree curves is a fact which is evidenced from sketches Figs. 2 and 3 herewith, Fig. 3 showing the method used to find whether engine will pass a curve or not. The following analysis of Fig. 3 will aid in illustrating what really takes place when a 2-8-0 engine is passing a curve:

When on a curve the flange of the front wheel *A* presses against the outer rail, and the hub of the driving wheel is brought against the box on the same side of the engine as the outer rail, tending to force the engine around into conformity with the center line of curve. The flanges of wheels *B* and *C* bear against the inside rail, and the hub of the wheel is brought against the box on the same side as the inside rail. Wheel *D*, or rear wheel, is forced against outer rail by the swing of the engine frame toward the outer rail, this action being caused by the curvature of the track forcing the wheel hubs *B* and *C* against the driving boxes, and thus forcing the wheels and engine bodily toward the outer rail, an amount equal to the total side play of wheels *B* and *C*.

Taking the engine shown by Figs. 2 and 3, and letting the center line of curve fall midway between wheels *B* and *C* and further (see Fig. 6), letting *P* equal height of arc for the total wheel-base, and *p* equal height of arc for wheel-base from *B* and *C* we have the following:

Radius = 358 feet (16 degrees).
Chord of arcs = 16 feet, and 5½ feet.
Then, letting R = radius
C and c = ½ chord of arcs.
P = height of arc for total wheel-base.
p = height of arc for wheel-base B to C.

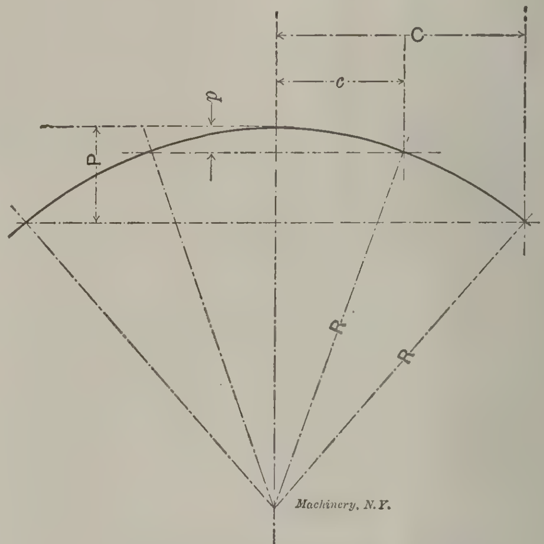


Fig. 6. Diagram Illustrating Geometrical Calculation.

We have by geometry the equation

$$R^2 - C^2 = (R - P)^2.$$

Or taking C as 8 feet (½ chord of arc for total wheel-base) we have

$$(358)^2 - (8)^2 = (358 - P)^2 \text{ or}$$
$$128164 - 64 = (358 - P)^2$$
$$\sqrt{128100} = 358 - P$$
$$P = 0.1 \text{ foot, or } 1.2 \text{ inches.}$$

Again taking same equation, and using for c the half-chord of arc for wheels *B* and *C*, or 2¾ feet, we have $(358)^2 - (2.75)^2 = (358 - P)^2$ or $128164 - 7.56 = (358 - P)^2$.

Hence $P = 0.02$ foot $= 0.24$ inch.

The actual height of arc which must be considered, therefore, is the measurement taken from points of contact of wheels *B* and *C*, and *A* and *D* and is equal to $P - p = 1.2$ inch $- 0.24$ inch $= 0.96$ inch, the latter figure being the actual side play required for passage of engine on curve.

Since the actual possible side play of the engine is $1\frac{9}{16}$ inch, as found previously, it may be seen that engine will readily pass the curve.

With regard to industrial plants, mines, etc., where extremely sharp curves are often necessary, it is the practice to widen the gage of track as much as the limit of car, or engine construction will permit, but this increase in gage will in no case ever approach the limits laid down in the article as it appeared in the July issue.

On narrow gage roads, the gage is usually widened 1/16 inch for each 2½ degrees of curvature, so that on a curve of

say 40 degrees, the gage would be widened $40/2\frac{1}{2} \times 1/16 =$ 1 inch.

As another illustration of the correctness of statements given herein, a 6-wheel switching engine with a 10-foot rigid wheel-base (middle tire without flange) will pass a 40-degree curve, or 143-foot radius, with a total side play consisting of ¼ inch box play, plus the play due to widening of gage, which is not more than 1¾ inch total at most, on standard gage roads, making a total of 2 inches side play. Gage is here taken as 1 inch wider than on tangent; and tires 53¼ inches apart, inside face to inside face of tire.

Consulting the table in the article as given in the July issue, 4 inches side play is required for a 150-foot radius curve, and 10-foot wheel-base.

For curves of from 35 feet to 50 feet radius, which cannot be stated in degrees, the gage must be widened accordingly, but it will be found that a rigid wheel-base in such cases is limited to from 4 feet to 5 feet 3 inches. In no case, however, is a side play of as much as 4 inches provided for.

In the calculations given herein, no regard has been paid to the fact that depth of flange below the rail has the effect of lengthening the wheel-base, since, with flanges 1⅛ inches deep, and small wheels, as usually found on engines with long, rigid wheel-bases, the addition to actual wheel-base from this cause is trifling, and need not be considered, particularly since an extra amount of side play over and above the actual requirements of the case, is always provided, to minimize wear and tear on flanges and rails. Besides this, it is open to question as to whether an allowance need actually be made for extension of wheel-base due to flange depth, since an inspection of standard flange in Fig. 1 will show that it is eased off, so as to clear the rail, and that the point of the flange cannot come into contact with the rail, unless the flange is worn in such manner as to make its wearing face a line at right angles to the wheel tread face. When sufficient wear has taken place to produce this result, it would then have the effect of lengthening the wheel base, as described in the article in the July issue, but since, at the same time, it would also have the effect of increasing the side play of the engine, due to wear, it may be seen that no allowance need be made for extra side play, on account of depth of flange on standard equipment.

Attention should be called to one fact, however, which is that on very heavy modern engines with maximum wheel loads, the rear wheels of a 2-8-0 engine, or even of 4-6-0 type, will have a tendency to ride against the inside rail, due to the fact that the friction between the wheel tread and rail face will be greater than the effect of the side swing of engine toward the outer rail, produced by the middle wheels pressing against the inside rail and bearing against the driving boxes at same time.

In such cases greater side play must be provided to pass a given curve than for a light engine of the same wheel-base in order to avoid distortion of the track or danger of derailment. The exact amount of extra allowance in such cases can best be determined by actual trial of the engines over the curves in question.

Finally, it should be remembered that no fixed rule or table can be given, providing for the exact amount of side play required for all styles of rigid wheel-bases, but each case must be considered individually, to determine the increased width of gage and side play between wheel hubs and boxes for passage over any given curve.

CHAS. A. BINGAMAN,
Asst. Chief Draftsman P. & R. Ry. Co.

Reading, Pa.

[For the benefit of readers unfamiliar with the method followed by civil engineers to express curvature in railway location it may be well to explain that the "degree of a curve" is determined by the central angle subtended by a chord of 100 feet. Hence the radius may be found by the formula $R = \frac{50}{\sin \frac{1}{2}\alpha}$, in which $\alpha =$ the degree of the curve, but for curves up to 10 degrees and even greater the common practice is simply to divide 5,730 (the radius of a 1-degree curve) by the number of degrees; this gives the radius with sufficient accuracy for most purposes.—EDITOR.]

BROWN SANITARY CLOSET SHIELD.

This sanitary appliance for a water closet is an entirely new construction, patented by Alex E. Brown, and manufactured by the Brown Hoisting Machinery Company, Cleveland, Ohio. Its construction has already attracted considerable notice and it is believed that a description will be of considerable interest to our readers in view of the peculiar difficulties attending the making of satisfactory shop arrangements of this sort.

It consists of a series of stalls, or compartments, as shown in Fig. 1, separated by concrete steel partitions (of the "ferroinclave" construction), attached to light angle supports, and covered by one concrete steel hood (also of the "ferroinclave"

Fig. 1. Row of Brown Sanitary Closet Shields.

construction), which runs to an apex at about an equi-distance from either end partition. At this apex is a ventilating pipe. With the exception of the two ends, the partitions do not extend up to the hood, thus giving sufficient air circulation. As will be seen in the cross section, Fig. 2, the hood extends out over the doors.

The doors are steel plates rolled in the form of semi-cylindrical shells. They are hung from the top on light angles, which extend across the partitions, and are so adjusted that in rotating on rollers they describe the path of a cylindrical shell about its vertical axis.

Some of the advantages of this appliance are:

1. A saving of space, practically three feet being saved by this door, over the ordinary side-hinged style.

2. Sanitary, the excellent hood or ventilating system taking away all odors, and the concrete walls allowing easy cleaning with a hose.

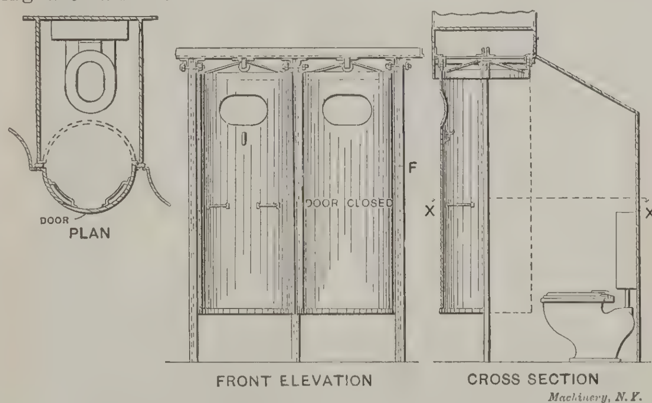


Fig. 2. Showing Construction of Brown Sanitary Closet Shield.

3. The interior is at all times closed to the outside view, thereby making it practicable to erect the same at points in a building that would be too exposed for the types of closet in ordinary use.

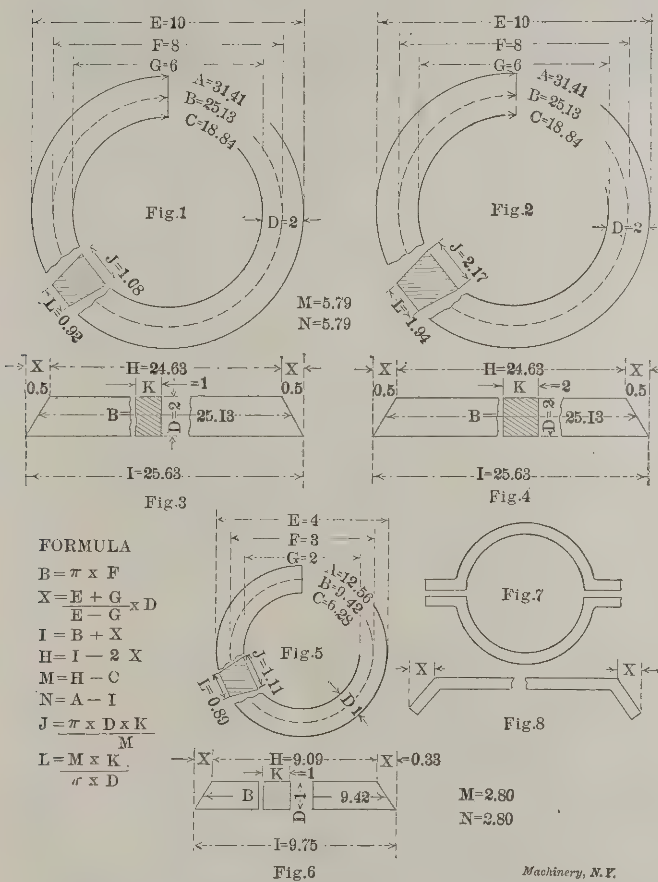
4. It can readily be seen by the door whether a closet is or is not occupied. A closet cannot be occupied without the door being out. This fact, together with the lack of light and the partitions, is the means of a great saving in time, in that it eliminates the usual causes for the men loafing.

FORMULAS FOR CONSTRUCTING RINGS MADE FROM SQUARE OR FLAT IRON BENT EDGEWISE.*

S. Uren.

In 1904 I was chairman of the committee on reducing railroad forgings to an exact science. At that time I was not prepared to give mathematical formulas for constructing rings made from square iron or flat iron bent edgewise; however, I have since produced formulas that will give the exact dimensions of a ring bent from square or flat iron, in its original shape before bending; also the exact dimensions of the ring after being bent.

Many different methods are employed by practical smiths to determine the proper length to cut the straight bar. The carriage smith will either roll the wheel over a long bar of iron or will use a small wheel and roll the outside of the wheel and the inside of the tire, making the allowance for the openings between the felloes, which method is correct. In a locomotive or manufacturing shop conditions are differ-



Formulas for Constructing Rings made from Square or Flat Iron.

ent as the smith works from drawings and in many cases has no means of measuring the circumference the ring is to fit over. Oftentimes the ring has to be finished on all sides in the machine shops and the proper allowance has to be made for finishing. Many smiths have different methods of calculating the straight length of the bar. Many use the old rule: "as 7 is to 22 so is the diameter to the circumference." Others, simply: "3 times the diameter plus 1/7 the diameter." Then again others use the simple method: "3 times the inside diameter plus 3 widths of the iron." The writer's method is to use the formula: "3.1416 multiplied by the diameter of the ring at the neutral axis of the bar."

The above methods are practically correct, measuring from the center of the metal but do not give the short and long side of the straight bar, as shown in Figs. 3, 4 and 6. I, as well as others, have searched mathematical and mechanical books for formulas that would give the different functions of a ring that has been bent from a heated bar of iron of given dimensions. I could not find anything bearing on the subject, consequently Mr. Harkins, my assistant foreman, who is an expert mathematician, and myself undertook to solve the problems and we have fully demonstrated and proved by experiments in actual practice of the formula.

Fig. 1 represents a ring bent from a bar of iron 2 inches wide by 1 inch thick. The usual custom of the practical blacksmith is to cut the bar to the length given by the formula: "3.1416 multiplied by the diameter of the ring," and to guess at the angle to which the end of the bar is cut. Oftentimes after the ring is bent, the inside will meet, leaving an opening on the outside, and if cut in excess, a similar condition occurs on the inside. In nearly all cases the smith will cut his iron long and trim to the proper shape after being bent. The formula of Fig. 2 is simple, and will give the angle; the end of the bar should be cut before bending. The difference between the long and short diameter, divided by the sum of the long and short diameter, multiplied by the width of the iron will give the required angle. The result in all cases should be added to the length produced by the above formula and the angle should be cut as shown at *X*, Fig. 2. If the ring is not to be welded, the ends will come together, forming a perfect joint.

It will be observed from Figs. 1 and 2 that the metal changes its shape in bending. The inside circumference of Fig. 1 is 18.84 inches. The length as shown in Fig. 2 to produce the circumference is 24.63 inches, or 5.79 inches in excess of the inside circumference of the finished ring. The reverse conditions exist in the outside of the ring. The actual length of the straight bar is 5.79 inches shorter than the actual outside circumference of the ring; consequently the surplus metal has to be accounted for on the inside of the ring and to be diminished on the outside. The extra metal increases the thickness of the inside of the ring, as shown in section at *J*, and decreases the thickness, as shown at *L*.

Oftentimes the smith has to make rings in sections, as shown at Fig. 4. The same formula will apply to produce the angle projections in the straight bar. The usual custom of the smith is to guess at the angle when forging the projections in the straight bar and set the ends properly after the section of ring is bent. The formulas are correct if the rings are bent at an even temperature and the metal has the same tensile and compression strength. Practically the metal has about equal tensile and compression strength at a bright red heat. When making rings from uneven shaped iron such as T-shapes or channel, the formula "3.1416 multiplied by the diameter" must be figured from the neutral axis of the bar.

Fig. 1 shows a 6-inch inside diameter ring produced from 1 × 2-inch bar; and Fig. 2 the same inside diameter ring produced from a 2-inch square bar. The figures obtained by using the formula correspond to the dimensions of similar rings produced in actual practice. Very few smiths realize that the length of the short side of the straight bar in a 6-inch ring 2 inches wide is 5.79 inches longer than the inside circumference of the ring and the long side as much shorter than the outside circumference. The formula to produce *J* is all that is required for whatever *J* exceeds *K* is the amount that *L* is less than *K*. The foregoing formula applies to diameters between 1 inch and 10 feet for large radii or railroad curves, the functions would be almost infinity.

* * *

The railway rate bill affecting all common carriers went into effect August 28. It gives the Interstate Commerce Commission authority to examine into all charges of unjust railroad rates and to fix the maximum rate in such cases. A failure to publish tariffs causes a carrier to be liable to a fine of from $1,000 to $20,000 in each case. No tariff may be changed without giving thirty days notice.

* Paper read by Mr. S. Uren (Southern Pacific Co.) before the International Railroad Master Blacksmiths' Association Convention, Chicago, Ill., August 21-23, 1906.

PLANING A SMALL MACHINE PART.

H. P. FAIRFIELD.

H. P. Fairfield.

The planer is in some respects one of the most interesting of machine tools. To quickly secure the pieces to be machined in such a manner as avoids springing them, and at the same time hold them fixed and firm against the thrust of the cutting tool, is seldom as simple a proposition as it might seem to be. The tool, while the cut is being made, tends to slide the work along the planer table in two directions for the horizontal plane, and beside this there is a tendency for the tool to tilt or tip the work. Any holding of the work must, therefore, provide against it moving, first, along the direction of the cut; second, across the planer table due to the pressure of the cut or feed, and third, to prevent any tilting. To furnish a method of fastening the work that provides for all these, and yet admits of quick handling, is that which in a manner differentiates one planer hand from an-

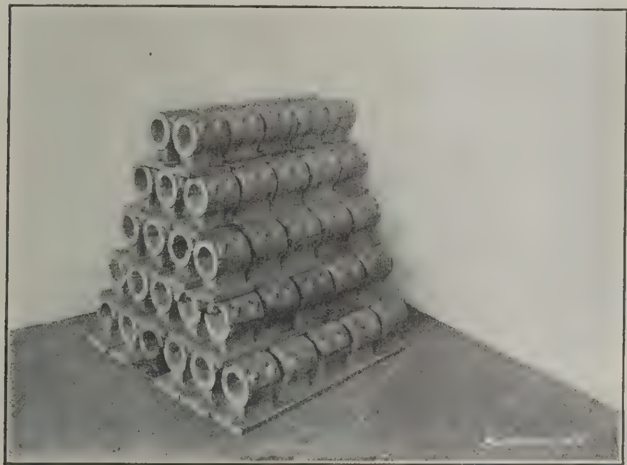


Fig. 1. A Pile of the Finished Parts.

other. Where the number of like pieces is large, it usually pays to design special jigs and fixtures with which to hold the work. This is especially true of small machine parts, and the fixtures are usually designed to hold a considerable number of pieces at one setting. Held in this way, setting the tool accurately for one piece sets it for the whole string of pieces, as it is termed. On the other hand, spoiling one piece

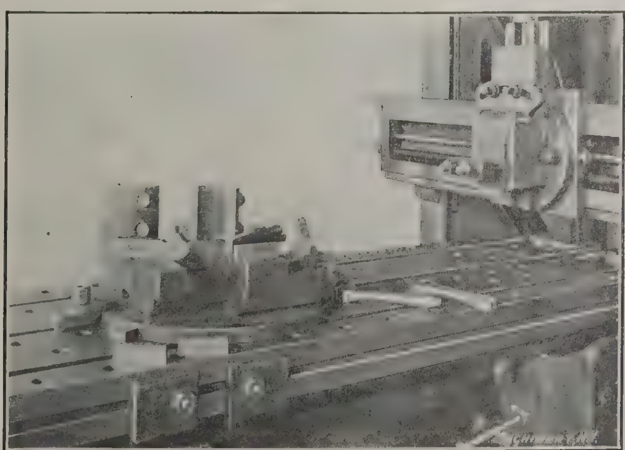


Fig. 2. Planer Chuck Used for Holding the Caps.

HOWARD P. FAIRFIELD was born at Patten, Me., in 1868. He served an apprenticeship with the S. A. Woods Machine Co., Boston, Mass., and has worked for the Boston & Albany Railroad, and the Goodyear Shoe Machine Co. Some years ago Mr. Fairfield left the commercial machine shop and became a teacher in the Case School of Applied Science, Cleveland, O., where he remained for eight years teaching wood-working, pattern-making, machine design, drawing, and machine construction. He left the Case School in 1899, and has since been connected in a similar capacity with the Worcester Polytechnic Institute, Worcester, Mass.

of the string usually spoils all. In so far as the cutting operations on the planer go, they are usually simple in their character, and should be easily mastered. As already hinted at, it is the ability of the workman as regards fastening, or holding his work, that counts.

In the half-tones herewith are shown the planer operations as performed upon a simple machine part—a cap box. No special methods for holding are shown, as all the fastenings used for holding this piece are those in common use for many other pieces, distinctly different in their outlines. Fig.

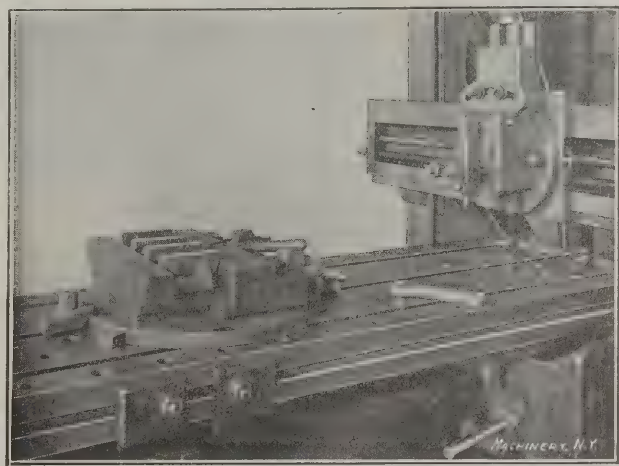


Fig. 3. Two Caps in Place in the Chuck.

1 shows a group of the pieces, planed, drilled, tapped, counterbored and fastened together with four filister head machine screws each, but only the planing operations are shown here.

An essential part of any planer outfit is a chuck for holding small pieces, and this is shown in Fig. 2. This figure shows also the tools used to rough cut and smooth plane the caps, seen standing at the top of the planer jaws. In Fig. 3 it will be noted that the chuck is held to prevent sliding along the length of the planer by two pins which fit holes in the table.

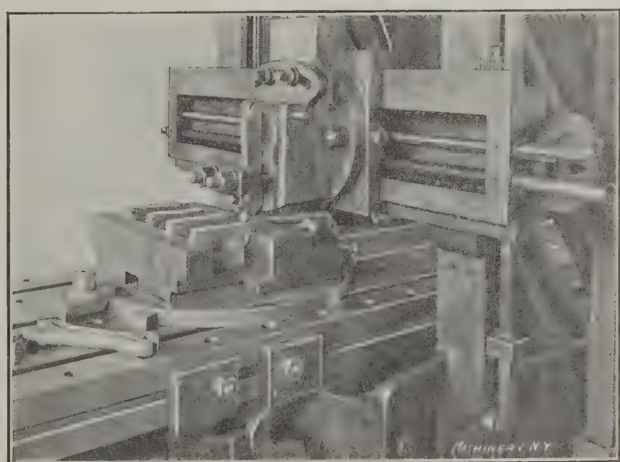


Fig. 4. The Tool in Position Ready for the Roughing Cut.

These are termed planer stops, and are used ahead of all work to prevent slipping due to the thrust of cutting. The work in this case is leveled by using short parallel pieces under the projecting ears on the cap. One jaw of the chuck is a fixed part of the base, while the other is made adjustable upon slides, and can be forced against the work by means of the screws shown at the right of the chuck base. If the pieces tend to elevate when the adjustable jaw is forced against them, light blows with a hammer will seat them again. Fig. 4 shows the tool in position, and the trips set ready to start the roughing cut, and Figs. 5 and 6 show the feed gear in place and the cut being made. The finishing tool used and its method of use is shown in Fig. 7. The tool is about one inch wide, and is fed a distance equal to two-thirds its width each stroke. In this case the feeding is by hand, the feed gear showing slipped out of mesh.

The base portion of the brackets lends itself very handily

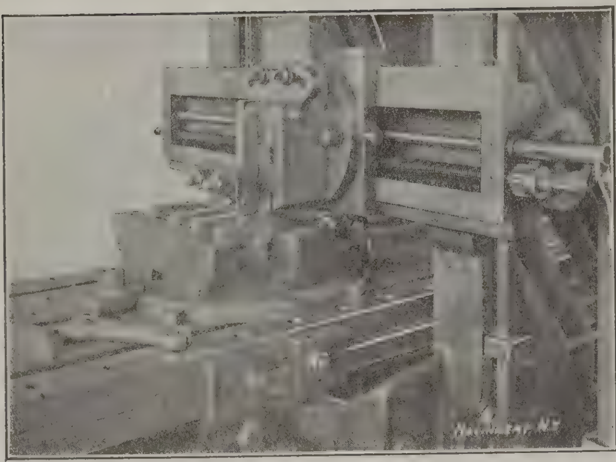


Fig. 5. The Feed Gear in Place.

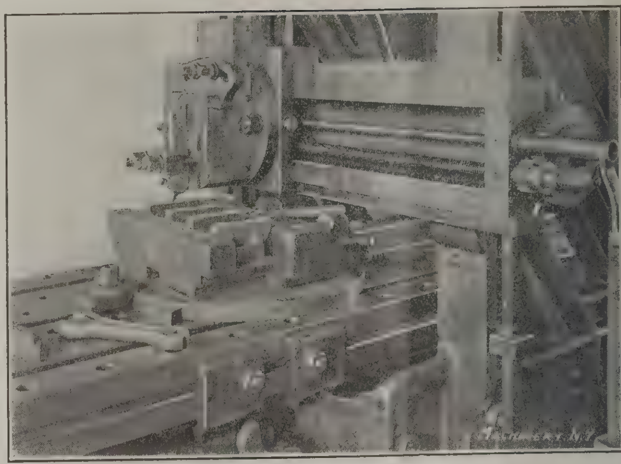


Fig. 6. Rough Planing the Caps.

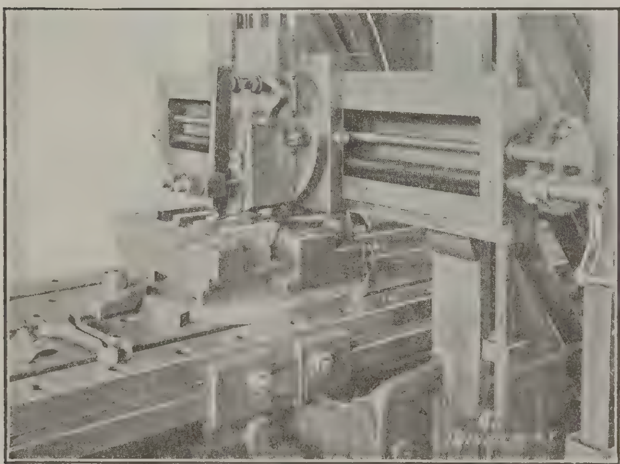


Fig. 7. Taking the Finishing Chip.

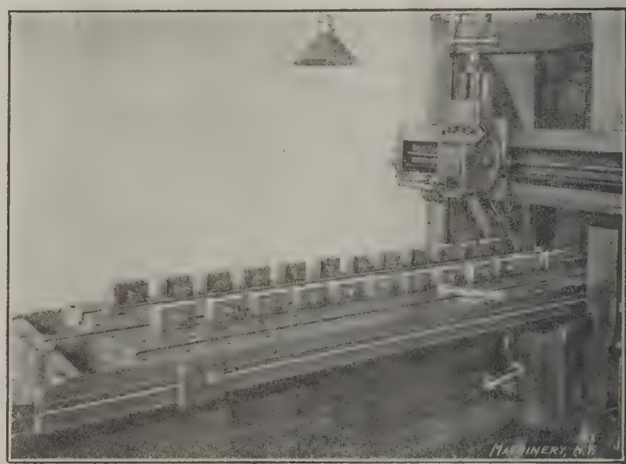


Fig. 8. Straps Used for Holding the Brackets.

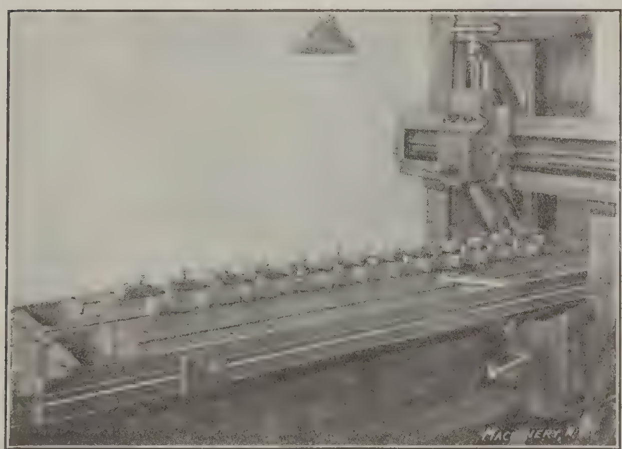


Fig. 9. Straps and Bolts in Position to Hold the Work.

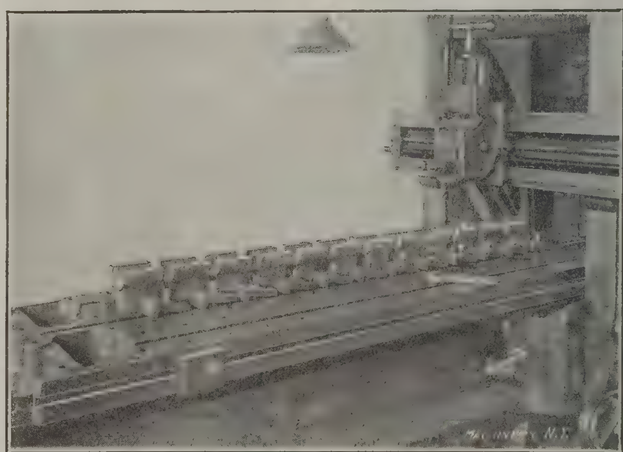


Fig. 10. A String of Brackets ready for Clamping.

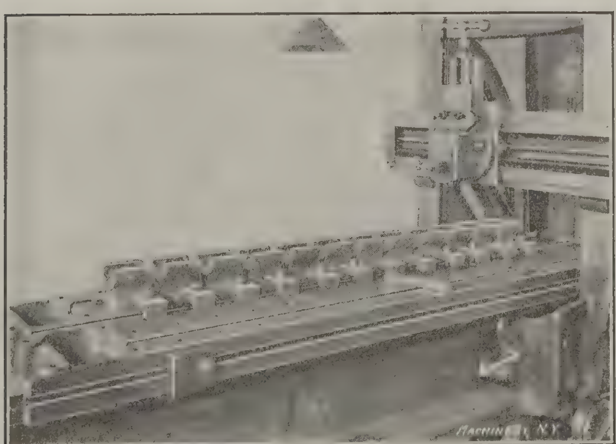


Fig. 11. The Work Clamped in Place.

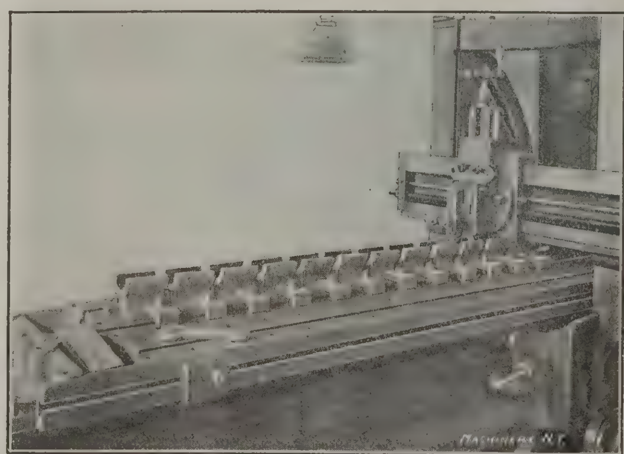


Fig. 12. The Roughing Tool ready for Action.

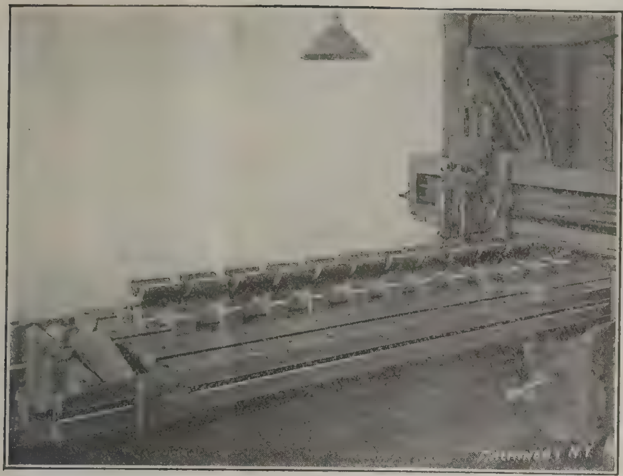


Fig. 13. Completing the Roughing Cut.

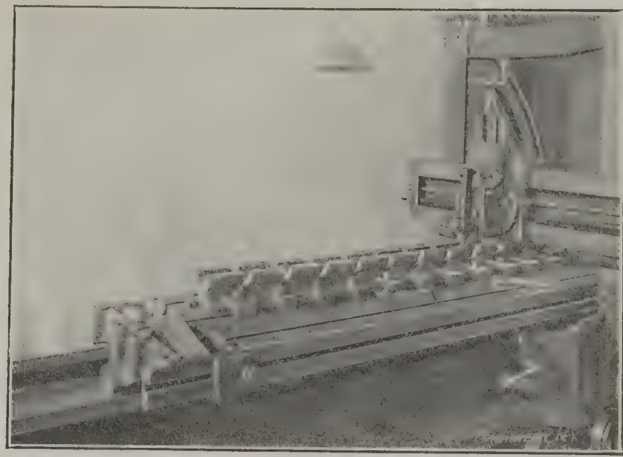


Fig. 14. The Finishing Tool in Place.

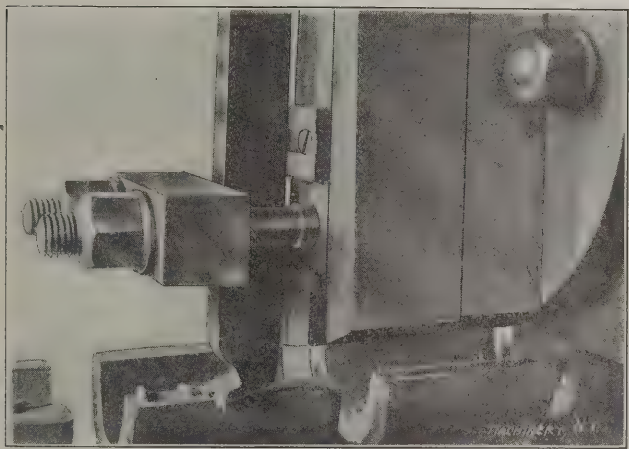


Fig 15. Taking the Finishing Cut.

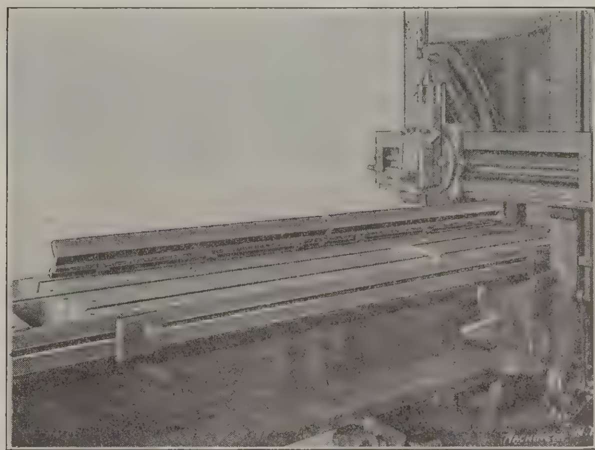


Fig. 16. Back Stops Used for Holding the Brackets Bottom up.

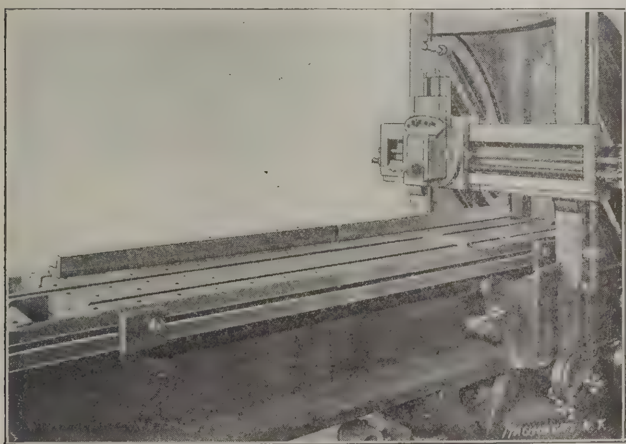


Fig. 17. The Back Stops Clamped in Place.

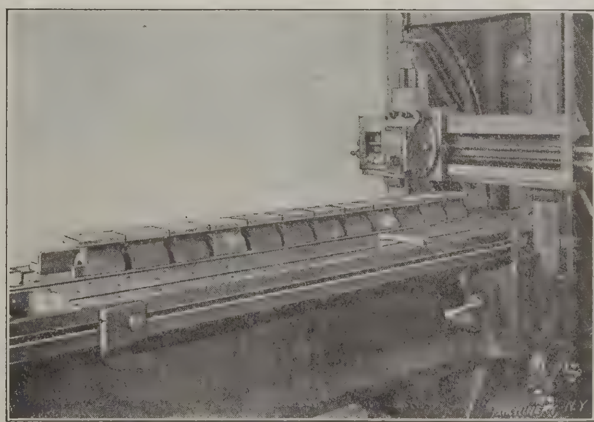


Fig. 18. The Work Lined up against the Stops.

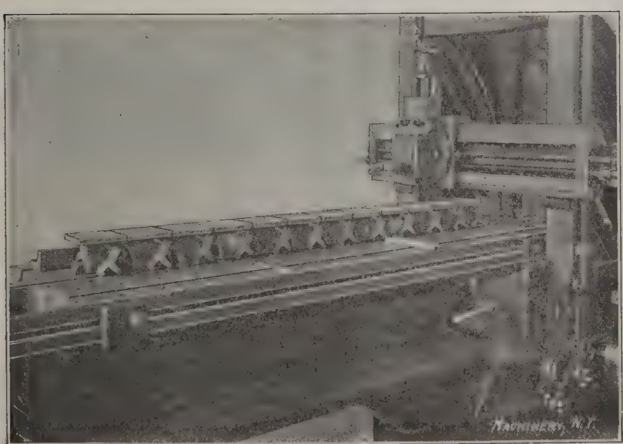


Fig. 19. Ready for Clamping.

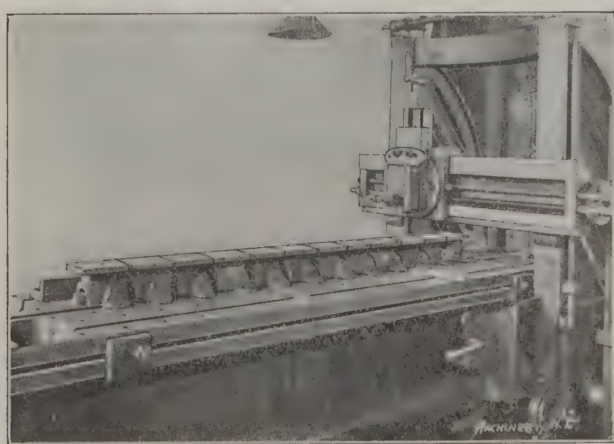


Fig. 20. Ready for the Tool.

to stringing, and Figs. 8 and 9 show the straps and bolts used to bind them to the planer table. In Figs. 10 and 11 the pieces are shown mounted in position, and strapped to the table. Fig. 12 shows tool set to take the roughing cut, and Fig. 13 the cut being taken. Note the stop against which the foremost piece butts to prevent slipping under the thrust of the cutting tools. The final cut is taken with the finishing tool, as in the case of the caps, and is shown in Fig. 14. Fig. 15 illustrates the finishing tool and its use, also the fact that it is *not* a scraping tool. In planing the reverse surfaces of the brackets, use is made of two back stops. Fig. 16 shows their form, and Fig. 17 their position on the planer table. The pieces are strung as shown in Fig. 18 butted against the pin stop. To hold them down the back stop is beveled back at its base (see Fig. 24), and the pieces are forced against it and down to the planer table by hook stops as shown in Figs. 19 and 20. The roughing tool is set as in Fig. 21, and does its work as shown in Fig. 22.

Use is again made of the finishing tool, as shown in Fig. 23. Fig. 24 is an end view to illustrate the surface as left by the finishing tool. Fig. 25 shows its use at close range and Fig. 26 the under surface of a bracket as it comes from this tool.

* * *

The 12-inch guns on board the *Dreadnaught* will be the most powerful ever carried by a warship. Altogether they will cost something like £113,200 ($550,152). The salient features of these guns are: Weight of gun, 58 tons; weight of shot, 850 pounds; weight of cordite charge, 325 pounds; shots leave muzzle at 2,900 feet per second; able to pierce at muzzle 51 inches of wrought iron. There are to be 10 of these, and each can fire two rounds a minute.—*Mechanical Engineer.*

[The muzzle striking energy, calculated by the formula $E = \frac{1}{2} Mv^2$, is over 110,000,000 foot-pounds, or enough to lift the whole battleship nearly three feet.—Editor.]

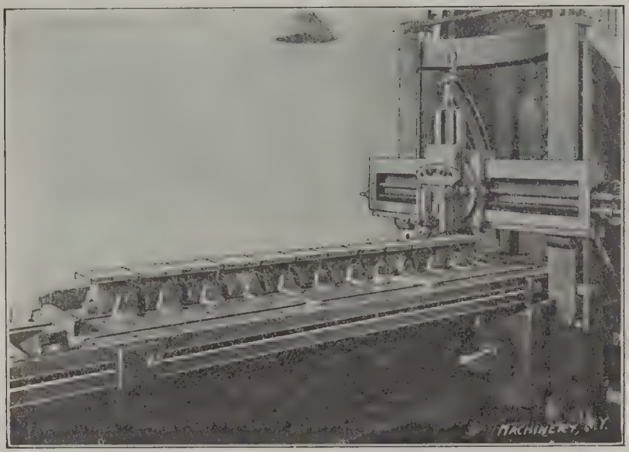


Fig. 21. Ready for the Roughing Cut.

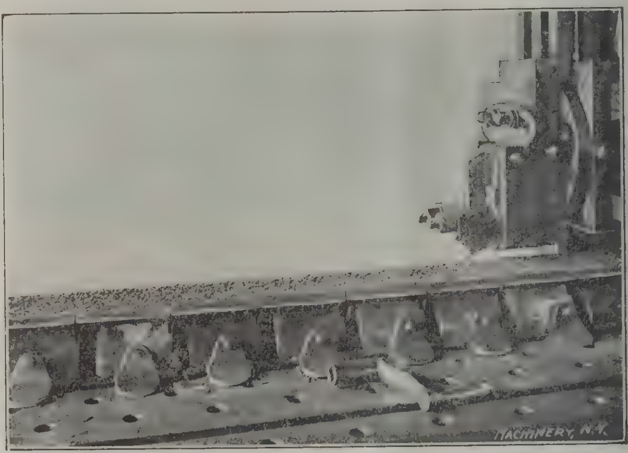


Fig. 22. The Roughing Cut Completed.

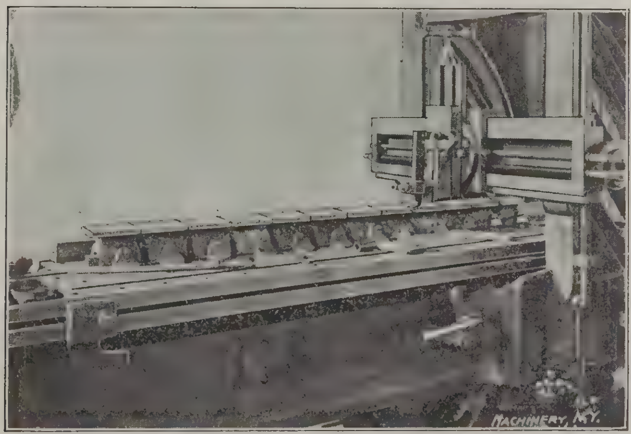


Fig. 23. Finishing the Base of the Brackets.

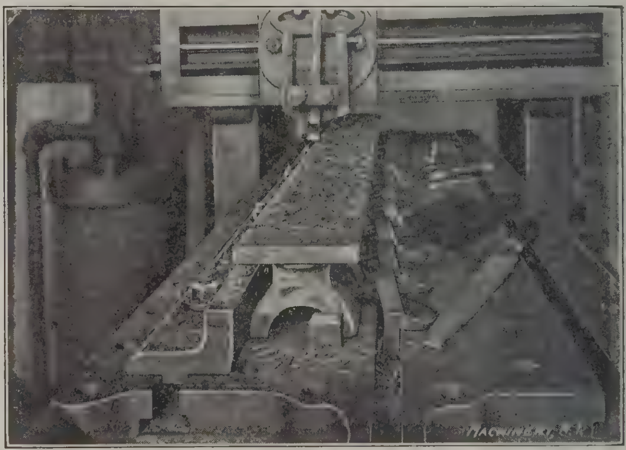


Fig. 24. The Finishing Cut Completed.

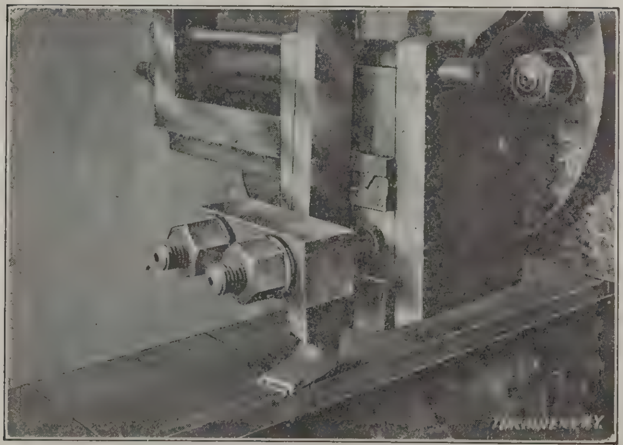


Fig. 25. Nature of the Finishing Chip.


Fig. 26. The Finished Surface.

TRACING, LETTERING AND MOUNTING.—1.

I. G. BAYLEY.

Tracing.

I. G. Bayley.

At the commencement of a drawing-office career only a few tools may be purchased, adding others as they are needed. Be careful to select the best; it will pay in the end.

A straight pen or two—one for black and one for red ink—a spring-bow pen, bow pencil, and dividers, and a half set of instruments comprising six-inch compass with fixed needle-points and interchangeable pen, pencil, and lengthening bar, will suffice. T-squares, triangles, pencils, rubbers, erasers, and pens are usually provided by the office. Keep to your own instruments, and have a private mark on your triangles, scales and T-square for identification in case they become exchanged.

Small instruments should be put away each night, as in cleaning up the office they are easily lost. A drawer or cupboard with trays or boxes for the various tools is very necessary for the draftsman.

Have a large clean rag duster or brush to wipe the board and T-square occasionally, as the least particle of dust getting into the pen will clog the ink, causing you to make a poor line.

In case the eraser must be used (a thing to avoid as much as possible) rub a little French chalk or soapstone well into the part erased. Keep a little of this prepared chalk by you; it can be procured from any artists' material store.

A piece of rag, cheesecloth or chamois skin hung by a thumb-tack or drawing pin at your side comes in handy for wiping the pens.

A sand-paper pencil sharpener and an oil stone completes the list.

Inks.—Too much cannot be said about the inks used, as I believe to a certain extent a great many bad tracings can be laid to the bad quality of ink used in the various drawing offices visited by the author, in this country and abroad.

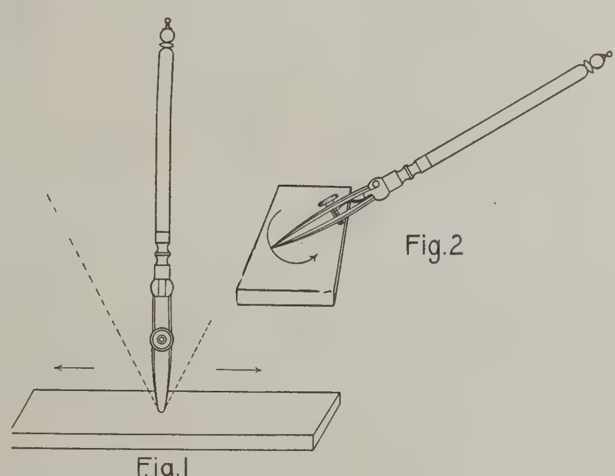
Good ink is indispensable, and no one should attempt to make a tracing until he has it. Some offices, to save (?) expense, resort to many ingenious ways of making ink by wholesale. A large bottle with a ground-glass stopper is provided. A quantity of broken ink (which can be purchased by the pound and much cheaper than buying by the stick or cake) is put into the bottle; a quart or so of ammonia is then poured over the ink. The bottle is then put in a warm place, shaken every now and then until the ink is dissolved, or partly so (the latter usually being the case) when it is supposed to be ready for use. This is the cheapest and worst way of making ink. Some drawing offices buy the ink ready mixed, put up in pint or quart bottles. For shop tracings, either of these methods may be resorted to. But for *neat* work it is almost impossible to get along with either; the only way is to mix the ink fresh each morning, washing out the pallet every day. When purchasing the ink sticks, the very best should be bought; it can be recognized by a pleasant odor which cannot be mistaken and is perceptible when grinding it in the saucer. The saucer, or pallet, should be spotlessly clean, and the water clear. Do not use too much water at first; more can be added as the ink is mixed. A little vinegar in the ink will keep away the flies. In many offices in warm climates they are a great nuisance; the writer has seen whole views completely eaten away by these pests in a very short time. Commence by rubbing a little Prussian blue in the saucer; this is not absolutely necessary, but it improves the ink somewhat and helps to thicken it quicker. Saucers made of slate with ground-glass covers are the best. The ink stick should be held firmly, but do not bear too hard upon it while grinding, or else when mixed the ink will be gritty. Grind until you cannot see the bottom of the saucer when blowing down upon the ink; this is a good test, and you can also see if the ink looks gritty. Try it on the edge of the tracing cloth or paper to see if it gives a clear black line. The cover should always be kept over the ink to keep it from evaporating and free from dust. In cold weather if the ink should thicken hold it before the fire or heater, when it will run easily and will not clog the pen.

Ordinary scarlet ink is used by some draftsmen for making red lines, although it is much better to use a mixed ink of crimson lake color, adding a little ox-gall to make it run. The prepared ox-gall in tiny jars can be procured from artists' material stores. In the absence of this a little soap rubbed into the color will answer the purpose. Bichromate of potash dissolved in the water before mixing the ink will help to keep away flies if you find they trouble you much.

It sometimes happens that boys are troubled with sweaty hands which mark the tracing as the work proceeds. This can be avoided by putting half a teaspoonful of ammonia in the water they wash their hands in.

Truing Up the Instruments.—As the pens are constantly used they will become blunt, which can be seen by holding them to a strong light and looking down upon the nibs. Every draftsman should be able to set his own instruments. There should be an oil-stone in every office for this purpose. Let it lie flat on the window sill or a table near to the light. Screw up the nibs tight, and holding the pen in an upright position between the finger and thumb, as shown in Fig. 1, move it backward and forward along the stone as indicated by the arrows, tilting it from side to side as shown by the dotted lines.

In this way a round and even surface is given to the nibs. They will be of the same length and true with each other. Now, holding the pen in a slanting position of about 30 degrees, rub the nibs upon the stone in a circular direction, as



Truing the Point of the Pen.

indicated in Fig. 2, rolling the pen as it were between the thumb and finger, turning it over and grinding both nibs alike. Hold the pen to the light occasionally to see if the nibs are level, and look down upon the points to see if the flat surfaces have been taken out. If sharpened correctly you will be able to see nothing, as when looking down upon the edge of a razor.

The thumbscrew must now be taken out and the inside edge of the pen be rubbed across the oil stone several times. Thoroughly clean the pen from any grit or oil and try it upon the edge of the tracing. If too sharp, it will have a tendency to run away from the T-square or straightedge, in which case it should be rubbed on the stone again, as in Fig. 1, though with care, as all pens should be fairly sharp.

The bow pen is trued up in the same way, with the exception that a thin slip of stone is passed between the nibs to take off any rough parts, as the nibs of the bow pen do not

I. G. Bayley was born in Ocker Hill, Tipton, Staffordshire, England, 1866. His education, outside of the common school, has been derived from home study and reading and courses with correspondence schools. He was apprenticed in the drawing rooms of the Old Park Iron Works, Wednesbury, Staffordshire, England. In addition to this company, he has worked for the King Bridge Co. and Globe Iron Works, Cleveland, Ohio, and Frank C. Roberts & Co., Philadelphia, Pa., in the positions of tracer, draftsman, checker, assistant head draftsman and designer. His specialty is mechanical drafting and designing.

hinge and some straight pens, too, for that matter, when they should also be treated in the same manner.

All instruments should have the best of care. When not in use for some time they should be kept clean and free from rust by wiping them on a piece of chamois leather greased with vaseline.

Tracing Paper.—Tracing paper is much used in architects' offices and occasionally by engineers for pencil sketching. When it is used for permanent work, the best quality should be had. But although it is possible to purchase paper capable of standing fairly rough usage, it is by no means as good as cloth.

A narrow strip of tracing cloth tacked along the lower edge protects it from being torn or soiled while leaning over the board. Either thumb tacks (drawing pins) or very small tacks may be used to hold down the paper; a small magnetized hammer can be used for the latter, picking the tacks up very quickly, so that which ever plan is adopted it takes about the same time.

In case the tracing will last for some time, or if there is any coloring to be done, the paper must be mounted on the board as described elsewhere.

Tracing Cloth.—For permanent work tracing cloth should by all means be used. Cloth is either glazed or unglazed, the foreign make being by far the best. With proper care a tracing may be taken up when complete, as clean as when cut from the roll. All shop or working tracings should be made on the unglazed or dull side of the cloth, as this side will take

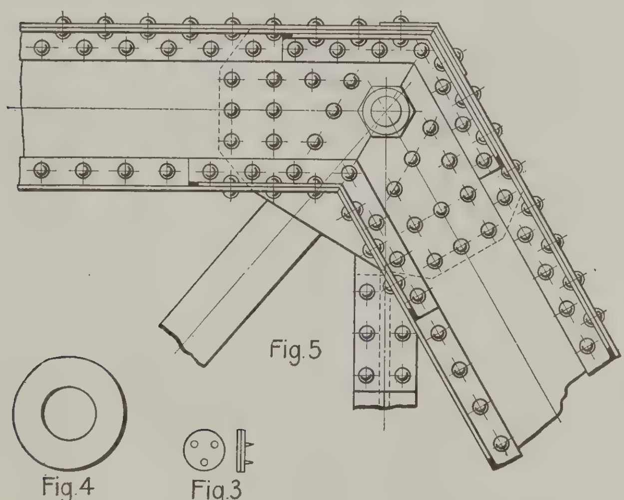


Fig. 3. Horn Center, Figs. 4 and 5, Examples of Shading.

pencil lines nicely, and when erasing has to be done it will not mar the surface so perceptibly. But for show or estimate tracings where much finer and neater work is required, the glazed side must be used. The lines will be sharper and the work will stand out much better. In either case the cloth should be laid down in the same manner as the paper. It should then be rubbed down with pulverized chalk.

Laying Down the Tracing.—The drawing to be traced is squared up with the board and wiped down with a dry cloth or duster. The roll of tracing cloth is run down the board and cut off to correct size. The edges at either side are then torn off quickly and the cloth laid down correct side up. A tack is put in the center of the top edge; the flat of the hand is drawn firmly but gently down to an opposite point at the lower edge, the fingers spread apart, while another tack driven between them holds that edge. Run the flat of the hand gently to the one side, driving in a tack; then to the opposite, stretching it well and securing it by another tack. The four corners and all intermediate spaces are then held down in the same manner.

With a dry rag or piece of chamois skin rub some pulverized chalk (or chalk scraped from the stick) all over the tracing cloth, dusting it off with a dry rag or brush. This will cause the pen to bite much better, especially in the case of show tracings where the glazed side is used. Some draftsmen use a little ox-gall in their ink for this purpose, but unless the exact quantity is used the ink will be very sensitive.

Tracing.—Everything is now ready for tracing. Try to understand the work as you proceed. If the job is likely to last long, work on one view and complete it, as sometimes the temperature of a room will change over night, causing the cloth to become quite flabby, and although it may be stretched again by holding it near the radiator or in the sun, yet it very seldom goes back to its correct position. But when making a smaller tracing which can be completed in a day, put in all the black lines first, the red or blue lines next (when making show tracings), the printing or lettering next, and finally the border and cutting-off lines.

Although as a rule red and blue lines are put in last, yet there are a few exceptions, as, for instance, when tracing a number of bolt or rivet heads in bridge or girder work; if a red line is run right through the heads, it will be easier to get them all exactly true and in line; otherwise they are apt to be put in in a very zig-zag way.

If the drawing is crowded the best plan is to stick to the rule and put red lines in last, as otherwise they will make the drawing hard to read by covering up work not yet traced. As a general rule, commence with the circles and curves first, joining the straight lines onto the curves, and not *vice versa.* When a number of circles and curves are struck from the same center, always commence with the smallest or inner one first while the center is good.

Sometimes a horn center, shown in Fig. 3, is used to protect centers from which a number of curves or circles are struck, as gear wheels, for instance. These horn centers are circular pieces of horn with three needle points. Some draftsmen glue a small piece of hard wood or horn over the centers. The pens should be tried upon the edge of the tracing to see what thickness of line they make, and when once set they should not be moved; for this reason some pens have small lock nuts on the thumbscrews. They should be wiped and the ink put in without again adjusting the screw. This particularly applies when making heavy lines. In this way all lines will be of the proper thickness. The pens can be filled with an ordinary writing pen or dipped in the ink sideways.

Working Tracings.—Working tracings or shop tracings are usually made a little heavier than others. The lines should be all the same thickness. No red or blue lines need be used, but all black, and although the tracings should be neat, especial care being given to the figures and dimension lines, yet such care need not be taken as when making a show or estimate tracing. The figures should be plain and simple and might be made a little large. The arrow points should be true and go exactly to their intended position. The figures should be checked before handing in the tracing so that as few mistakes as possible will come back to the tracer.

Show Tracings.—Estimate or show tracings should have a little more time expended upon them. The lines need not be so heavy and as a general rule are shaded, *i.e.,* the lines furthest from the light, which is supposed to come from the top left-hand corner, should be heavier than the others; this is clearly shown in Fig. 5. Shade lines can be made by going over the lines again or adjusting the screw of the pen, causing the ink to make a heavier line. When dark-lining a circle the radius is kept, but the center changed slightly, as shown in Fig. 4; or the same center and radius may be kept, going over the dark or shaded side several times with the pen.

The letters, figures and dimension lines should be made neatly, the arrow points evenly made. Some draftsmen put in the arrow heads with their spring bow pen, and since they can be put in just as quickly this way and look much neater it would be well to practice this method.

Dotted lines should be finer than full ones. The dots and spaces should be the same length—about one-thirty-second to one-sixteenth inch in length.

In shading rivet heads sometimes a small half circle is made inside the first, as shown in Fig. 5. It should be heavier than the outline of the rivet head.

The heading or title should be neat and attractive and a fancy border line might be made. All notes or stray words should have a neat red line drawn under them. Bolt heads should be neatly made and all small work neatly executed. Threads of bolts should be parallel and equally spaced, and

may be accurately drawn or indicated, as shown in Fig. 6, *c*, *d* and *e*. Dotted work can be shown to advantage if the dots forming the apex and root of the threads are united, as shown at *e*. These may seem trifles, but they all tend to make a neat tracing.

Holding the Instruments.—The author has been more than surprised at the rough and unsteady way which some drafts-

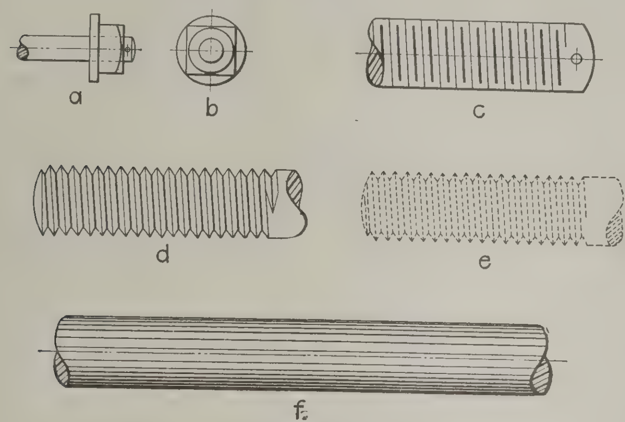


Fig. 6. Screw Threads and Shading.

men have of holding their instruments. The bow pen should be held lightly at the top between the thumb and first two fingers, resting the little finger upon the tracings to steady the instrument while finding the position for the point. This being found, the little finger should be lifted and the bow pen cleverly spun between the thumb and first finger. It is good practice at your leisure to see how quickly you can make a number of small circles; in this way you will get into the knack of cleverly spinning the bow pen as described, instead of holding it in an awkward manner.

The straight pen should be held in a slightly inclined position, the thumb-screw on that side away from the T-square or straightedge and with the second finger resting upon the screw to adjust if necessary.

* * *

The steps which have been taken by the Japanese government for the nationalization of its railways, and the recent developments in the industrial and commercial situation in Manchuria, indicate that that nation has determined on a definite policy of government control of commerce and manufacturing. Consul-General Miller in a recent report from Yokohama says:

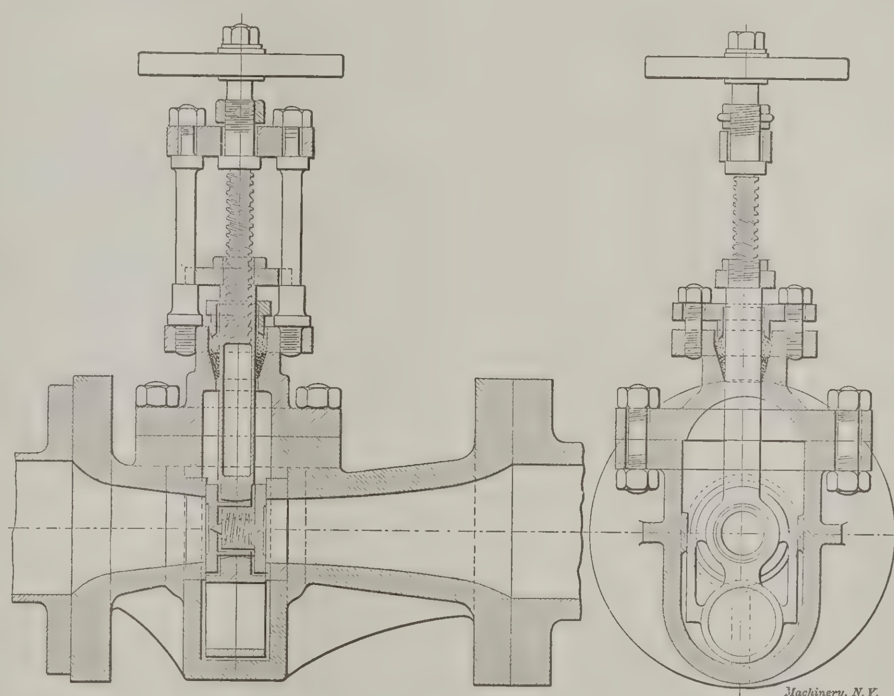
"She is undertaking one of the greatest experiments in the world's history in the relations between government and industry. If successful along the lines she is now working on, the individuals and corporations of America that are striving for the trade of the Orient will discover that they are not competing for this trade against individuals and corporations of Japan, but that they are in commercial conflict with the Japanese nation. I am convinced that this is the condition to which American manufacturers and merchants must look forward and be prepared to meet.

"The financial world seems now to be in keen competition to provide Japan with money for almost every purpose, and the lack of wealth is not likely to retard her industrial and commercial expansion. In viewing this great Japanese experiment of nationalization of industries it is not wise to prejudge it, and assume it will be a failure because it would fail in European or American countries. A thorough knowledge of Japanese history and character will cause any thoughtful person to hesitate before pronouncing it impracticable."

THE HOPKINSON-FERRANTI STEAM VALVE.*

The manufacture of stop-valves has now been carried on for so many years that one might well have thought that finality had been reached. We are, however, indebted to Mr. Ferranti for a radical departure in valve construction, which promises to considerably modify existing practice. The valve works upon the principle of converting the pressure of the fluid to be controlled into velocity, passing it through a comparatively small orifice, in which the working parts of the valve are placed, at a high velocity, and then reconverting the velocity into pressure again by means of a suitably formed nozzle. We give an illustration of the valve, which is being manufactured by the well-known firm of Messrs. J. Hopkinson & Co., Limited, of Huddersfield. From the engraving its construction will be readily understood. The new idea is so simple, and the advantages of the valve are so obvious, that it seems strange that it has not been invented long ago. It must be remembered, however, that accurate knowledge on velocity and pressure conversions of elastic fluids is of quite recent date; and it has only been by a combination of circumstances that the present development has been brought about. As the result of very careful design and a large number of experiments, Mr. Ferranti has produced a valve with very much smaller working parts, through which the drop of pressure, under normal circumstances, is negligible, and which is capable of carrying the heaviest overloads. This valve can therefore advantageously take the place of an ordinary full-bore straight through valve.

As will be seen from the illustration, the steam entry to



The Hopkinson-Ferranti Steam Valve.

the valve is formed of a conical nozzle. It has been found advisable in practice to make the throat of this nozzle half the diameter of the pipe in which the valve is placed, and it therefore has one-quarter the area. In this throat the operative parts of the valve are placed. These are made according to Messrs. Hopkinson's well-known construction, the discs and seats being of their "Platnam" metal, which has been found very durable under the most severe conditions. As, however, it is of the utmost importance that the path should be perfectly smooth, so as to avoid as much as possible loss from eddying, the moving part of the valve is of special construction. This will also be seen from the illustration, which shows that the moving parts are so constructed that when the valve is closed the ordinary discs are in position against the faces; and when the valve is opened a smooth tubular passage is brought accurately into line between the cones forming the path through the valve.

**London Engineering*, June 29, 1906.

The steam, on leaving the throat, passes through a diverging nozzle and converts its velocity into pressure; and it is the smoothness of the throat and correctness of the whole path which are of such great importance in giving the valve a high efficiency. The nozzles, both leading to and from the throat, have been designed on the basis of equal conversion of energy per unit length of the path, so as to obtain the minimum loss by eddying. Every precaution is taken in the design and manufacture of the valve to ensure the tube which forms the path through the throat being in accurate alignment with the nozzles when the valve is full open. To give an idea of the importance of the smoothness of path in the throat it may be stated that when this special construction is replaced by the parts ordinarily found in a straight-through valve, the drop of pressure at once becomes serious.

The advantages to be obtained by the use of this valve are very important. The new valve, for the same capacity as that of an ordinary straight-through valve, is very much smaller in size, and is of about half its weight. This matter, though not so important on land, is one of very great importance on board ship, where everything possible is done to reduce weight. One of the most serious troubles in large steam installations is that of valve leakage, and in the valve in question it will be seen that with equally good manufacture the leakage must be at most one-half, owing to the periphery over which leakage can occur being half that in the ordinary valve. But, as is well known, the smaller the structure the stiffer it is possible to make it, and it is therefore probable that the leakage will be reduced by a good deal more than half.

Another advantage is that the valve does not require a by-pass; as it is found that partly owing to the reduced area of the opening and partly to the conical approach to the opening, the flow of steam is almost directly proportional to the number of turns given to the controlling wheel. There is, therefore, no rush of steam on opening, such as one gets with ordinary valves, and there is a continually increasing and nearly proportional flow right up to the last movement of the handle. This is a matter of considerable importance, as by careless opening of valves a good deal of damage has resulted at different times, from the sudden rush which takes place. Owing to the progressive flow through the present valve this danger is done away with. Moreover, in valves of fair dimensions, such as are now being very generally used, the work of opening and closing is very considerable. The present valve has to be moved against a quarter of the load on account of the reduced area of its working parts, and for only half the stroke of a normal valve, and the work of opening and closing may therefore be put down as approximately one-eighth of that at present required.

The lagging of steam-pipes for the purpose of saving heat losses is now generally done with very great care; and in steam installations where the engineers are concerned with the good appearance of their pipe-work it is always a very serious difficulty to so lag the valves as not to lose heat, and yet, at the same time, to prevent their spoiling the general appearance of the plant. The new valve, as will be seen from the illustration, lends itself very specially to being well lagged; in fact, the diameter of the lagging required for the pipes is about that which is required for entirely enclosing the hot part of the valves, and thus a neat and workmanlike job can now be made of the covering of a pipe system.

Many engineers will, no doubt, have come across the difficulty and annoyance arising from the fact of their having to provide different flanges upon their steam-pipes where these are jointed to stop-valves, owing to the welded-on flanges suitable for pipe-lines being too small in diameter, and having bolts at too small a radius for connecting to the cast-iron or cast-steel valve-bodies. This difficulty is entirely overcome in the new valve. It will be seen from the figure that the cones of which the valve is formed enable the bolts to be put close enough in to the center to allow of standard pipe-line welded-on flange being used. The importance with the new valve of being able to keep standard pipe-line flanges throughout the pipe system is very great, and will be much appreciated by engineers.

APPLIED SCIENCE REFERENCE ROOM OF THE PRATT INSTITUTE LIBRARY.

Most of us have been discouraged at one time or another in hunting for information on scientific subjects in the public libraries with which our country abounds. It is often exceedingly difficult to make practical use of them in obtaining information on mechanical engineering, for instance. This is due in many cases to the poor selection of books on this and kindred subjects. Many of the works are old and out of date, while the newer ones will very likely be found to belong to that large class which either gives no useful information, or else has it arranged in such form that it is unavailable for practical use. In contrast with this common condition it is with pleasure that we call attention to the efforts that are being made by those in charge of the Pratt Institute Free Library of Brooklyn, to make their applied science reference room of the greatest possible value to the community in which it is located.

Unlike most other large cities Brooklyn is not served by a large central library with sub-stations in outlying districts, but is instead supplied with a number of smaller and practically independent ones located in different sections of the city. Among these the Pratt Institute Library, although in reality a private institution, supplies the needs of a large residential and manufacturing district. It is therefore provided with a full collection of works on history, art, criticism,

A Corner of the Applied Science Reference Room.

poetry, biography, fiction, etc., as well as with such special books as are needed for the scholars and teachers of the school of which it is a part. It is only with the equipment of the applied science room, however, that we are concerned. This is located on the main floor of the building and is open every day, except Sunday, from 12:30 to 9:30 P. M. and can be used between 9 A. M. and 12:30 through the library office. Over one hundred trade and scientific papers are subscribed to, besides about fifty labor union papers, the most important of the trade journals being bound and preserved for reference. The transactions of all leading scientific societies of England and America are also to be found on the shelves, and a full set of patent office reports is available. The cases on the side walls contain classified selections of books dealing with applied chemistry, metallurgy, mechanical and electrical engineering, building trades, and allied subjects. The half-tone will give an idea of the arrangement and appearance of the room.

The point to which special attention should be called, however, relates to the active effort made by Mr. Edwin M. Jenks, who is in charge of this department, to make it as useful as possible to those who may be helped by it. A liberal appropriation is made yearly for the purchase of new books, and this is expended, as far as possible, on the recommendation of practical men interested in the various subjects with which the collection of books is concerned. A careful lookout is kept for the scientific books in the circulating department of the library which are most often taken for reference, and such

books are either placed in the reference room or, if the circulating demand is also large, a new copy is bought.

Furthermore, Mr. Jenks has been making a survey of his district to locate the position and nature of the various industries represented there. From this information an industrial map is being prepared which is expected to be of considerable service. Visits are made to manufacturing establishments from time to time, when the library is brought to the attention of the different manufacturers, and permission is asked to post notices about the plant and to distribute cards calling attention to the equipment of the reference room. In addition to this, classified lists of the available books concerned with the various industries are being prepared by men who are familiar with the practical conditions involved. These lists give not only the name of the book and that of its writer, but describe in a few words the nature of its contents and the manner in which the subject is treated, thus saving much trouble on the part of the user. Of these lists, the catalogue of books on electricity has been completed. Another innovation is the collection of mounted cuts which have been clipped from various books and periodicals and indexed in such a way as to be available for reference. This includes a great variety of pictures of machines and mechanical devices which may be used in the room or taken away if desired. A man desiring to get ideas in the line of chucks, for instance, would find a large collection of illustrations here from which he might get helpful suggestions.

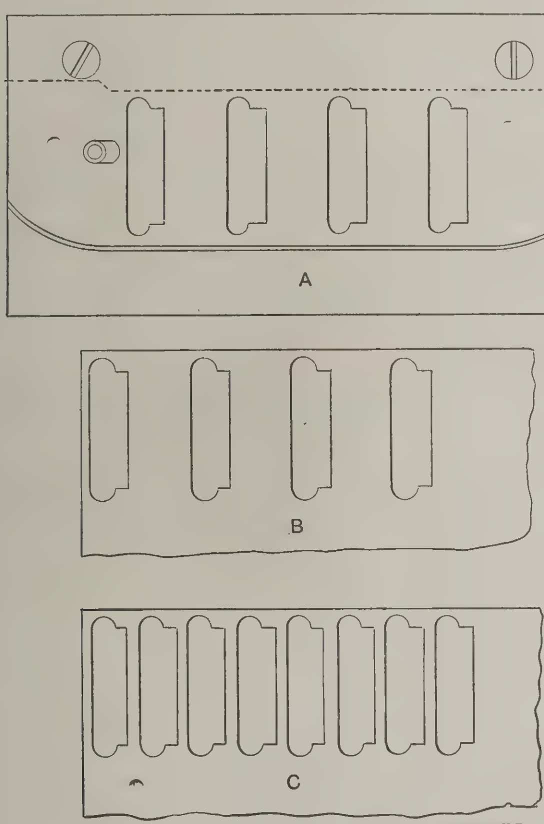


Fig. 40. Arrangement of a Multiple Die.

In general those responsible for this reading room appear to have their ears to the ground, if the expression may be used, and give evidence of being sincerely desirous of making it a useful institution. With these intentions so plainly evinced it would seem to be the fault of the user of the library if it did not prove to be of service to him in his work. This example is commended to the attention of other similar institutions.

[Since the above was written, we have received the catalogue of books therein mentioned. The pamphlet is entitled, "Books on Electricity, an Annotated List." It measures 4½ x 7 inches, and describes some three hundred works. These are classified in a way which is convenient for reference. Any one to whom this list would be useful may obtain a copy by addressing a request to the Pratt Institute Free Library, Brooklyn, New York.]

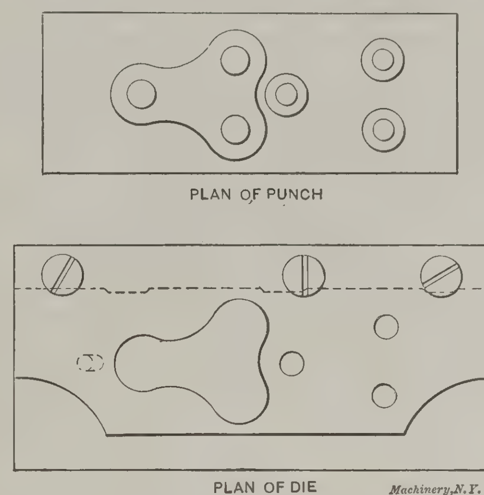
PUNCH AND DIE WORK.—3.

E. R. MARKHAM.

Multiple Dies.

The reduction of the cost of manufacture is often possible by the use of multiple dies, whereby two or more pieces are punched out at a time. In punching perforated steel work it is no uncommon thing to see punches and dies in use where several hundred punches are working into one die.

If an article, for example, of the form shown in the die in Fig. 40, were to be punched in lots of several thousand, the die should punch a number at a stroke. Such a die and the stock left are shown in Fig. 40, where the die is shown at *A* and the stock after the first punching at *B*. It will be noticed that the distance between the openings is considerable. This is necessary, as it would not be possible to place the openings in the die as close as they should be to economize stock, since there would not be stock enough between to insure the die sufficient strength to stand up when working. For this reason the openings are located as shown. After punching as shown at *B*, the stock is moved along the right distance so the intervening stock can be punched out, as at *C*.



Figs. 41 and 42. A Gang Punch and Die.

Gang Dies.

If it were desirable to punch a piece like that at *a* in Fig. 43, it would be possible to make a blanking die and punch which would produce the blank of the right size and shape, but without the holes; then, by means of another die, with three punches working into it, we could punch the holes. It is apparent that such a method would be more expensive than one that made it possible to punch the holes and the piece at one passage of the stock across the die. This may be done by the use of a die of the description shown in Figs. 42 and 43. When using this die the stock is placed against the guide and just far enough to the left so the large punch *b* will trim the end. Then, when placed against the stop or gage pin *c*,

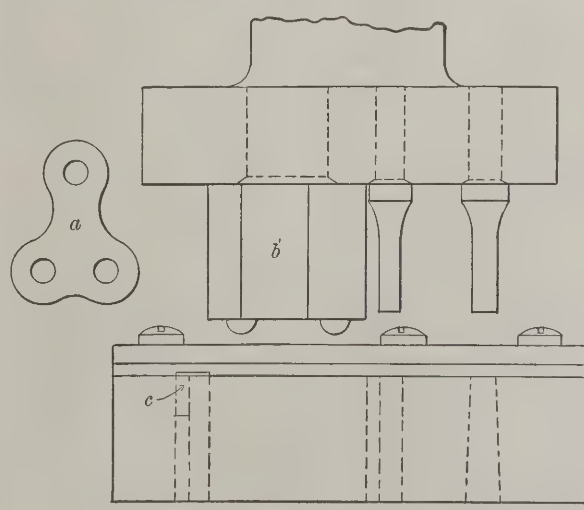


Fig. 43. Elevation of Gang Punch and Die.

bring the guide pins in end of punch *a* in line with the holes punched at the first stroke of the press at the time the end was trimmed.

When the stock is purchased of the proper width for one piece, it is fed through and the scrap thrown aside. At times it is purchased just wide enough for two pieces, in which case one edge is placed against the guide *d* and the stock fed through; after which it is turned over and fed through with the opposite edge against the guide, thus using all the stock except such portion as went into scrap.

However, if the stock is purchased in the commercial sheet, it is necessary to trim the edges every time a row is punched along each. If no power shears are located handy to the press this may prove to be a more costly operation than the punching, and no matter how conveniently such a shear may be located, the operation adds a considerable cost to the product. To avoid this trouble and expense another punch and opening to the die may be added. The object of this punch is to remove the scrap between the openings in the sheet and also trim the edge of the sheet, thus making it straight and in condition to bear against the guide on the die. The die and punch with the addition mentioned are shown in Fig. 44.

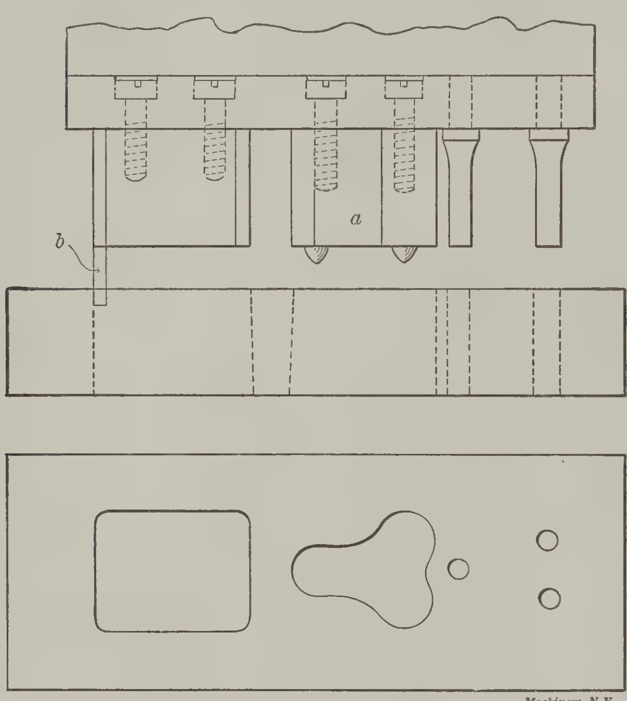


Fig. 44. Gang Punch arranged to use Sheet Stock.

When using a trimming punch as described above, it is necessary to use a stop of the description shown at *b*. The end of the scrap striking this governs the location of the stock, and when the punch descends the scrap is cut away.

When making dies of this class it is necessary to have the blanking die *a* the longer in order that the locating pins on the end may engage in the holes in the stock and locate it right before the other punches reach the stock. It is also necessary to place the stop, or gage pin, so the stock will go a trifle further than its proper location—say 1-100 inch. Then when the locating pins engage with the holes they draw the stock back to its proper location; whereas if the tool maker attempted to locate the stop exactly any dirt or other foreign substance getting between the end of the scrap and the stop would cause trouble.

Bending Dies.

While it is possible, in certain cases, to bend articles during the operation of punching it is usually necessary to make a separate operation of bending. There are instances where bending fixtures which may be held in a bench vise, or attached to the bench, answer the purpose as well and allow the work to be done more cheaply than if bending dies were used. But as a rule the die used in a press provides the more satisfactory method and allows the work to be done at a fraction of the cost.

It is sometimes possible to make the dies so the various operations can be done in different portions of the same die block, the piece of work being changed from one portion to another in order as the various operations are gone through. At other times it is necessary to make several sets of bending dies, the number depending on the number of operations necessary. When a "batch" of work has been run through the first die it is removed from the press and the next in order placed in, so continuing until the work has been brought to the desired shape.

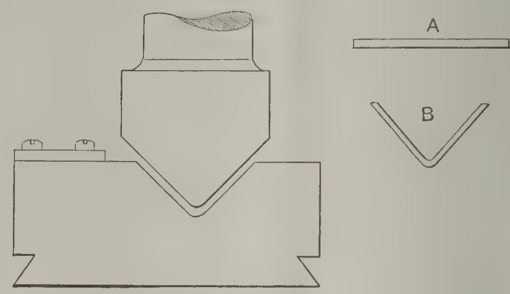


FIG. 45

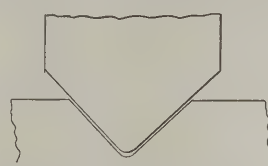


FIG. 46

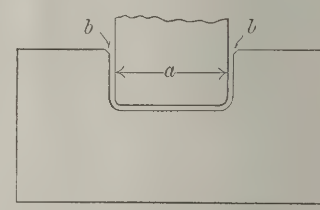


FIG. 47 Machinery,N.Y.

Examples of Bending Dies.

When a comparatively small number of pieces are to be bent to a shape that would require a complicated and consequently costly die in order that the work might be done at one operation, it is sometimes considered advisable to make two dies, which are simple in form and inexpensive to make, to do the work.

At times the design of the press is such that a complicated die could not be used; and as a result additional dies of a simpler form and which can be fitted in the press must be made.

We will first consider the simpler forms of bending dies. Fig. 45 represents a die used in bending a piece of steel *A* to a V-shape, as at *B*. In the case of a die of this form it is necessary to provide an impression of the proper shape as shown; this impression, if the die is to be used for bending stiff stock, must be of a more acute angle than if stock having little tendency to spring back when bent to shape be used. Under ordinary circumstances the upper portion or punch would be made of the same angle as the die. It is necessary to provide guides and stops as shown to locate the work properly.

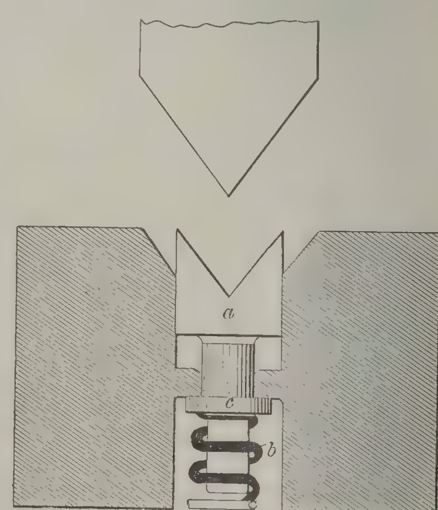


Fig. 48. A Bending Die for Accurate Work.

If the stock used in making the pieces is of a high grade and the product is a spring or similar article which must be hardened, it will be found necessary to cut away the die somewhat in the bottom of the impression, making it a little different in shape from the punch as shown in Fig. 46. This is to prevent crushing or disarranging the grain of the steel to an extent that would cause it to break when in use.

If the die is of the form shown in Fig. 47, it is, of course, necessary to make the length *a* of punch shorter than the distance across the opening of the die. It must be somewhat shorter on each end than the thickness of the stock being

worked. If possible, the upper corners *b b* of the die should be rounded somewhat, as the stock bends so much easier and with less danger of mutilating the surface than when the corners are sharp. When bending thin ductile metal the corners need but little rounding. If the stock is thick, or very stiff, a greater amount of round is needed.

While the form of bending die in Fig. 45 answers for ordinary work, there are jobs where such a die would not insure a degree of accuracy that would answer the purpose, and it will be found necessary to make one similar to Fig. 48, where a riser or pad *a* is provided as shown. This is forced upward by the spring *b* and is gaged as to height by means of the

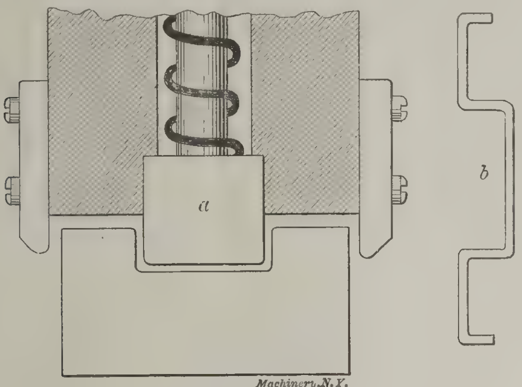


Fig. 49. A Case of Progressive Bending.

washer *c* bearing against the shoulder as shown. It will be observed that the spring gets its bearing against the washer, which in turn bears against the shoulder of the riser as mentioned before.

When making this die the hole is drilled and reamed and the groove milled or planed for the riser, which is put in place sufficiently tight to hold it while the V groove is cut, after which it may be relieved until it works freely.

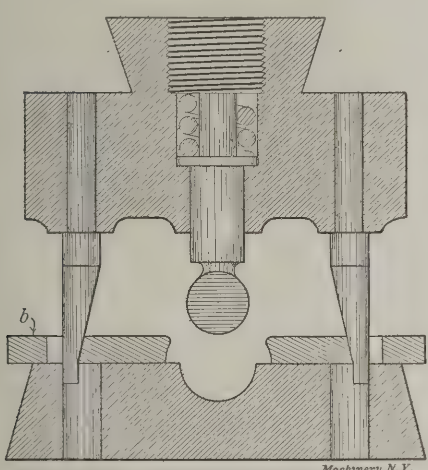


Fig. 50. A Die for Bending Bow Springs.

The spring *b* gets its lower bearing on the die holder. If it is considered advisable a screw may be provided for the spring to rest on. By moving this screw any desired tension may be given the spring, although generally speaking this is not necessary.

When bending articles of certain shapes it is necessary to design the tools so that certain portions of the piece will be bent before other portions. Should we attempt to make the tools solid and do the work at one stroke of the press, the piece of stock would be held rigidly at certain points and it would be necessary to stretch the stock in order to make it conform to other portions of the die. In the case of articles made from soft stock, this might be accomplished, but the stock would be thinner and narrower where it stretched. However, as a rule it is not advisable to do this, and dies are constructed to do away with this trouble.

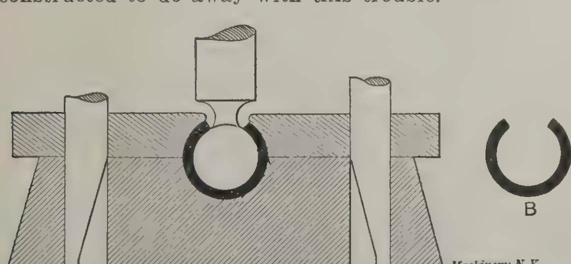


Fig. 51. Action of the Die in Fig. 50.

Fig. 49 represents a die, the upper part of which has the portion *a* so constructed that it engages the stock first, after forcing it down into the impression in the lower portion. Part *a* recedes into the slot provided for it. The coil spring shown is sufficiently strong to overcome the resistance of the stock until it strikes the bottom of impression. The article is shown bent at *b*.

Fig. 52. Successive Loops Formed in a Wire.

Compound bending dies are used very extensively on certain classes of work, especially in making looped wire connections and articles of thin sheet stock.

Fig. 50 shows a die used for bending a bow spring. As the punch descends the stock is bent down into the impression in the lower half and forms the stock to a U-shape. As the end of the punch with the stock comes in contact with the bottom of the impression it is forced into the upper portion, the spring keeping it against the stock while movable slides—side benders—*b b*, are pressed in by means of the wedge-shaped pins so as to force the upper ends of loop against the sides of the punch as shown in Fig. 51, forming the piece as

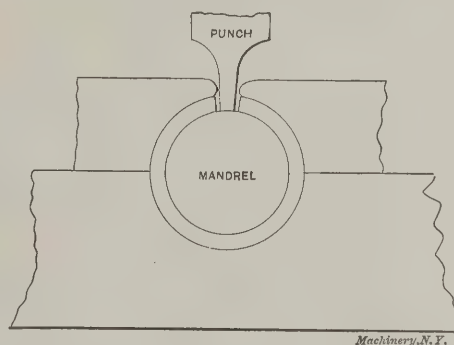


Fig. 53. Forming a Stiff Bow Spring.

at *B*. When the punch ascends, the finished loop may be drawn off. If the stock used is stiff it will be necessary to make the punch somewhat smaller than the finish size of spring, as it will open out somewhat when the pressure is removed.

When making looped wire work, a loop may be formed and the wire moved along against a stop; another loop formed, and so on, as in Fig. 52. When forming looped wire work it is customary to make the punch ball-shaped rather than as shown in Fig. 50. The ball answers as well on wire work and allows of the easy removal of the loop.

It is sometimes desirable to close the upper end of an article nearly together and if the stock used is extremely stiff,

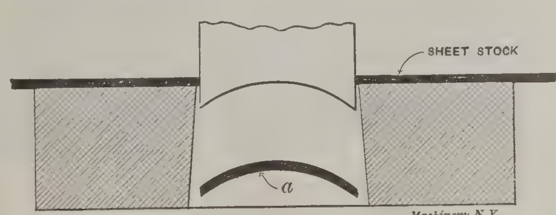


Fig. 54. Punching and Bending at One Operation.

as bow springs made from a grade of tool or spring steel, it may be necessary to heat the bow, which has previously been bent, red hot, and finish bending it by a special process. In the case of articles made from a mild grade of stock this may be accomplished at the time of bending by substituting a mandrel as shown in Fig. 53, for the cylindrical portion of the punch.

A great variety of work may be done by modifications of the forms of bending dies shown. Where but a *few* pieces are to be bent it is not advisable to go to the expense of costly bending dies; but when the work is done in great numbers they will produce work uniform in shape at a low cost.

Blanking and bending dies are made which not only punch

the article from the commercial sheet, but bend it to the desired shape at the same operation.

As a rule it is advisable to blank the article at one operation and bend it at another, but there are certain forms of work where it is possible to do it in a satisfactory manner at one operation and at a cost not exceeding that of the ordinary blanking operation. This also effects a saving in the cost of tools, as the special bending die is dispensed with.

Fig. 54 represents a punch and die used in punching the shoe *a* to the shape shown, while Fig. 55 is one used for producing the tension washer shown.

Gun and other irregular shaped springs are many times punched to form by this style of die, although when stock suitable for use in making springs is employed it will be

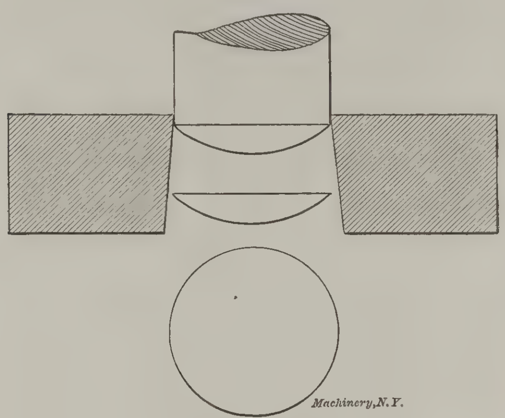


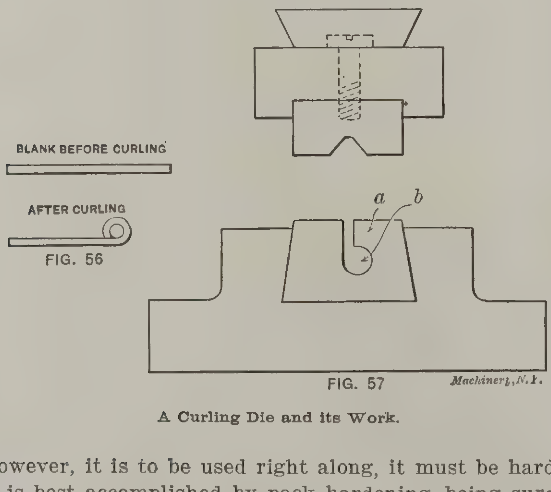
Fig. 55. Making a Tension Washer.

found necessary to make the face of the punch somewhat different in shape from that desired, as the piece will straighten out more or less after it is punched.

If it is desired to curl a form on a piece of work, making a loop as in Fig. 56, it is accomplished by various methods, sometimes by a modification of the die of Fig. 51. A die of the description shown in Fig. 57 is used with excellent results.

In making this die the blank *a* is first machined to size. The hole *b* is drilled and reamed to size and polished to produce very smooth walls. This may be accomplished by using a round revolving lap of the right size. The slot is then milled as shown.

If the die is not intended for permanent use and the stock is comparatively soft or easily bent, it need not be hardened.



A Curling Die and its Work.

If, however, it is to be used right along, it must be hardened. This is best accomplished by pack hardening, being sure that the heats are low. As in the use of this method the die is quenched in oil, there is little or no danger of its going out of shape. Draw to a full straw color.

The punch is made with a V-shaped impression in its face as shown. This may be rounded in the bottom as indicated or left sharp, as desired. If hardened, it may be drawn to a brown color.

It is possible with presses and tools adapted to the work to form pieces to shapes that to one not familiar with this class of work would seem well nigh impossible.

CONCERNING THE VARYING VALUE OF THE DOLLAR.*

Forty years ago, at the close of the Civil War, the United States was doing business with a depreciated paper currency, worth only half and at times even less than half of its face value in gold. While the situation was clearly understood by the financial experts of that day, it was not understood by people in general. Buying and selling, lending and borrowing, went on as if the dollar were an unvarying standard of value, and with no foresight of the impending change. The debtor who borrowed a thousand dollars for a term of years had seldom any idea that he would actually at the end of the term have to pay the creditor in dollars twice as valuable as those he had originally received. The hardships growing out of this change in the value of the dollar were enormous and widespread. They were in large degree responsible for the greenback craze of a decade later and for other financial vagaries which have afflicted us since. No one who clearly understands the situation resulting from the depreciation of paper money in the '60's and '70's can doubt that a currency of fluctuating value is one of the worst evils that can befall a people.

While the financial issue on which public attention was concentrated a few years ago did much to educate the public in the elements of sound finance, there is one fact now pressing on public attention which was rather obscured in the discussion. We refer to the fact that the dollar, even when based on the gold standard, is not by any means an unvarying standard of value. The enormous production of gold during the past twenty years appears to have been one important factor in the depreciation of the dollar which has recently occurred. Theorists have often speculated as to what the result would be if a deposit of gold should be somewhere uncovered from which the metal could be produced in unlimited quantities at a labor cost much below the present value of gold. It is evident enough, of course, that such an event would absolutely reduce the purchasing power of gold everywhere; and to a certain extent, it is claimed, the great production of gold in South Africa, Alaska, and Colorado has tended to produce a similar result.

That a great change in the value of the dollar has occurred is apparent to even the dullest observer. The value of money is measured, of course, by what it will procure. Dollars are worthless except as a universally accepted medium of exchange. If a dollar to-day will buy no more in food, clothing, shelter, personal service or other commodities than half a dollar would procure half a century ago, then it is a fair conclusion that the value of the dollar has diminished by one-half. One has but to refer to records of the first half century, showing prices paid and cost of living in those days, to be absolutely convinced that a great change has taken place in the value of the dollar in that period. We do not, however, need to go so far back by any means. In the current number of *Moody's Magazine*, a writer compares the average commodity prices in 1897, at the end of a long period of financial depression, and those of the current year. According to these figures, as compiled by R. G. Dun & Co., there was an average increase in price in that period, nine years, of 47 per cent. That means that it now takes $1.47 to buy what $1 would have bought nine years ago.

It is curious to note that this rapid change in the value of the dollar (and the gold dollar, too) has exactly reversed the situation between debtors and creditors that existed in the early '70's. Then the creditor got back from the debtor—if the debtor remained solvent—much more than he originally lent. To-day, if a man loaned money nine years ago at 5 per cent and were now to be paid back the principal with simple interest, he could not purchase as much with the whole as he could with the principal alone when he lent the money. In other words, the shrinkage in the value of the dollar has more than offset all the interest it has earned.

This decline in the value of the dollar must not be confused with another decline which has been going on at the same time, the decline in the rates of interest; yet to a certain extent the two react upon and influence each other. Twenty-

* *Engineering News*, June 28, 1906.

five years ago a hundred dollars loaned would earn six dollars interest every year. Now a hundred dollars loaned will earn only three dollars and a half a year; and that three dollars and a half will only purchase as much as a dollar and seventy-five cents did at that time. The "bloated bondholder," who has so long been held up to scorn, therefore, is now actually receiving from the same principal an income less than a third as great as that which he enjoyed twenty-five years ago.

It has seemed to us that these facts are worth bringing to the attention of engineers. While they may, in a way, be well known, we are all too prone to forget them. We unconsciously think of the dollar as a standard of value; but if it is a standard it is one whose dimensions are varying like a piece of india rubber. We think of wages and salaries as if the dollars could be compared with the dollars paid in wages and salaries twenty years or even ten years ago. It needs but the least thought to see that this is not at all the case. The man, be he president, chief engineer, college professor, surveyor, blacksmith or ordinary laborer, who is paid the same number of dollars per day or per year that he was nine years ago, has actually suffered a reduction in his salary or wages of nearly one-third. He can actually buy only two-thirds of the necessaries or comforts of life to-day that he could nine years ago. On the other hand, these changes of values are creating riches on every hand. Those whose property consists in actual things—real estate, railways, ships, mines, stores and what not, have often seen a jump in the value of their holdings which was due only partially to their shrewd business judgment and largely to the fact that the dollar has depreciated in value and thus made their property worth more dollars.

Will there be a return to the lower prices of a former day? So far as the value of the dollar is influenced by the rate of gold production, there is no prospect of any reduction in the output of the world's mines. Rather, with the constant exploration of new countries and the rapid development of chemical and mechanical processes for treating low-grade ores, a steady increase in the world's gold production seems probable, at least for a long period to come. There are, moreover, causes tending toward higher prices for various commodities, such as the growing scarcity of lumber and various metals, or the inability of the sources of supply to keep pace with the expansion of demand. It will be understood, of course, that an increase in price of any important commodity, to whatever market conditions it may be due, operates to decrease the value of the dollar. Inevitably, too, there must be a further readjustment of wages and salaries in many departments to correspond with changed conditions above set forth. All these things tend to make permanent the decreased purchasing power of the dollar and to bring about still further decrease.

[Of direct bearing on the above is the following quotation from a letter recently published in the *Outlook* (London): "There is every reason to believe that prices in the next fifteen years will rise enormously, reverting to the price level of the decade 1867 to 1877. This rise will be unfairly ascribed to the operations of the trusts and to the advance which should equitably take place in railway and steamship rates. The real reason, however, will be the depreciation of gold by reason of its abundance. So recently as 1883 the yield of the mines was only 4,614,588 ounces. For 1905 it was 18,211,419 ounces. If Mr. Bryan in 1896 and bimetallists the world over merely desired inflation they have since got inflation with a vengeance, and inevitably far vaster inflation awaits us."]

* * *

The increasing interest in "industrial betterment" is shown in the work being done in Kinkora, on the Delaware River, 10 miles below Trenton, N. J., where John Roebling's Sons are reported to be expending $4,000,000 in providing homes for their employees. Expansion of their business led to the erection of new mills near Kinkora, and the consequence was the building of homes for the workmen, including a hotel conducted on the plan of a private club, and a department store. A single man will be enabled to enjoy life for $2.50 per week and the houses will be rented for from $8 to $14 a month.

THE RANSOM CYCLOMETER OR SPEED INDICATOR.

The not unusual conception of the motion of a steam engine flywheel is that of uniformity of angular velocity, varying somewhat, of course, in number of revolutions per minute but not to any great extent within a revolution. This, however, is a mistaken idea as any one knows who has made an analysis of the subject, or has had to do with the operation of even very closely regulated multiple cylinder steam engines driving large alternating current generators, required to work synchronously in pairs or in multiple. The accompanying cut, Fig. 1, shows in diagrammatic form, steam engine fluctuations varying 5 per cent from perfect regularity of angular motion, and gas engine fluctuations varying 6¼

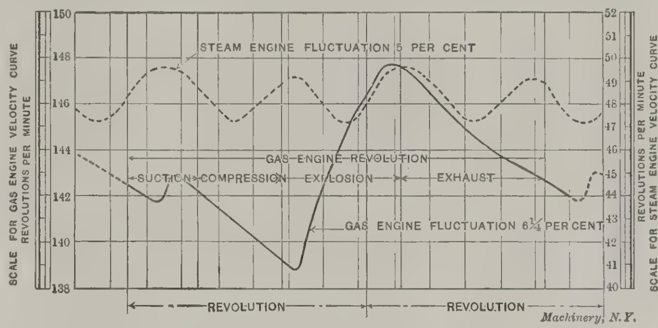


Fig. 1. Comparative Speed Variations of Gas and Steam Engines.

per cent. The Ransom cyclometer by which these variations were detected is of considerable interest and through the courtesy of the makers, Messrs. Manlove, Alliott & Co., Ltd., Nottingham, England, we are enabled to present herewith photographs of the instrument and the accompanying description:

The Ransom cyclometer shown in Fig. 2 is an instrument by means of which the time of rotation of any shaft may be measured to the one-five-thousandth part of a second and not only is the total time of each revolution recorded but also the time taken in turning through any minute angle or portion of a revolution may be obtained with equal accuracy. The principle upon which this speed recorder works is very simple. A cylinder or drum covered tightly with smoked paper is connected to the end of the engine shaft or other shaft whose speed it is required to measure. On one side of

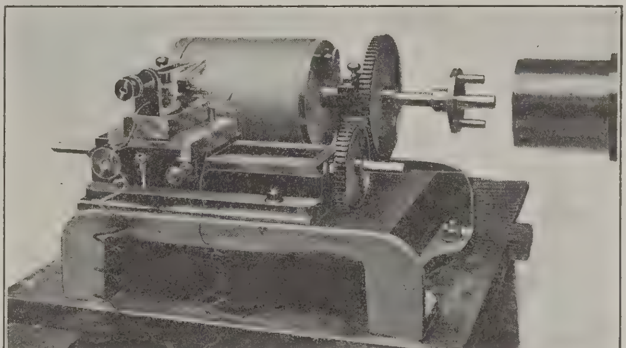


Fig. 2. The Ransom Speed Indicator.

this drum is mounted a tuning fork of known pitch one arm of which carries a small needle or style. When the fork is vibrating this needle oscillates in a line at right angles to the direction of rotation of the drum and lightly touches the surface of the smoked paper. Fig. 3 shows a short section of a record made by a standard tuning fork making 512 vibrations per second. It is one of the fundamental laws of sound that each vibration must be made in an equal interval of time, the amount of which is known from the pitch of the fork, hence each of the cycles represented on the surface of the smoked paper represent equal intervals of time. Knowing the pitch of the fork and having given a section of paper on which the style has traced a record, it can be readily deduced how long a period of time was required for the traverse of any portion of it while passing under the style.

In order that more than one revolution of the drum may be recorded the tuning fork is arranged to travel automatically along the whole length of the drum, or any portion of it that may be desired. The record then presents the appearance of a fine helix composed of waves on the surface of the paper. The records made on smoked paper are removed from the drum and the marks rendered permanent by a thin coating of varnish.

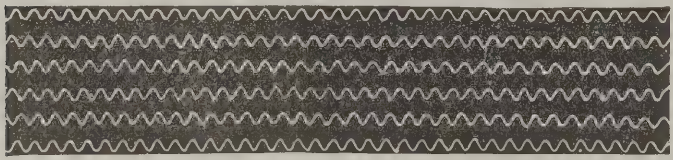


Fig. 3. Record Made on the Smoked Paper.

The diagram shown in Fig. 1 was plotted from tests made on a good tandem compound steam engine indicating about 15 horsepower, and on an "Atkinson cycle" gas engine. The gas engine shaft, of course, receives only one impulse to four impulses received by the steam engine shaft, and although both engines make about the same number of revolutions per minute it will be noted that there is a considerable difference in angular velocity. The gas engine was regarded as an uncommonly steady running machine, although the cyclometer showed fluctuations in speed of 6¼ per cent during a period of one revolution.

Fig. 2 shows the cyclometer; a spur gear is mounted on the drum shaft which meshes with another gear mounted on a lead screw. This latter traverses the carriage on which is mounted the tuning fork shown on top. Between the prongs of the fork is a small electro-magnet connected to a battery by means of which the action of the tuning fork is stimulated, and by the use of which a trial may be prolonged for any required time. The end of the drum shaft is provided with suitable connection for the shaft to be tested. It is thus evident that the construction and use of the instrument is quite simple and readily within the grasp of any one competent to test machinery. The fact that the tuning fork has an unvarying rate of vibration is, of course, the fundamental idea on which the machine is founded. The principle has been much used for time recording in physical science experiments but its application to machinery testing is of comparatively recent date. Fig. 4 shows the application of the instrument to an Atkinson cycle gas engine.

* * *

BUILT-UP CRANK SHAFTS FOR MULTI-CYLINDER ENGINES.*

In some of the very earliest gasoline vehicle engines of the high speed European type, built-up crankshafts were employed. That is, the shaft, its cheeks or webs, and the crank-pin were not made integral, but of separate elements, mechanically joined. In many of the early enclosed flywheel engines two balance wheels were used, each wheel being keyed to the closely abutted ends of the halves of the shaft. The crank-pin being passed through and made fast in the rims of both balance wheels, the halves of the main shaft were thus mechanically joined.

The built-up crank-shaft was early abandoned in favor of shafts hand or drop-forged out of a single piece of stock, the shaft proper, as well as the cranks and crank-pins for the number of throws desired, being formed integrally. Some of the highest quality automobile engines have been fitted with shafts not forged but machined or cut very laboriously out of a solid rectangular slab of steel, large enough to include the extreme outside dimensions of the shaft, cranks and pins.

* *Horseless Age*, July 4, 1906.

Crankshafts for four-cylinder engines are expensive pieces of mechanism, and the shafts required by six- and eight-cylinder motors are necessarily much more so, especially if they are constructed in accordance with the best precepts of the art.

Rather recently the built-up crankshaft has been proposed for modern motors, and several designs have been brought out. Such shafts are constructed upon a sort of unit system. The units from which a crankshaft of any number of throws may be built up are identical and consist of the forged cheeks of a crank, the crankpin and two short stubs forming parts of the shaft proper.

The ends of these stubs are made in the form of jaw couplings and two of the units may be united by interlocking these jaws, so that neighboring throws shall stand at any desired angular relation, one to the other, as required in the construction of multicylinder shafts of all types. The interlocked parts of neighboring units form the bearing portions of the shaft itself and the ball bearings in which the shaft runs do not, under this construction, have to be threaded over the cheeks of the cranks. The internal diameter of the ball bearings may therefore be reduced with an advantage in point of strength of the bearing.

It is probable that crankshafts built up in this manner from a number of similar units can be produced quite economically. The burden of keeping on hand ordinary crankshafts for motors of various types and numbers of cylinders is quite serious, and there should be a certain advantage in being able to build up a shaft for a motor of any number of cylinders upon this unit system.

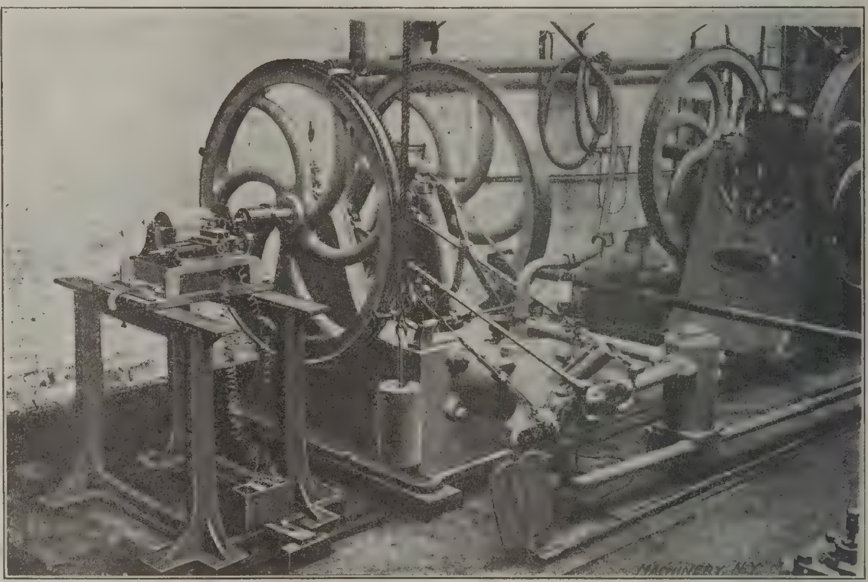


Fig. 4. The Apparatus in Use in Testing an Atkinson Gas Engine.

Damage sustained by any part of a built-up shaft should be more readily repaired than a corresponding accident to an integral shaft—a fracture of which is usually fatal, despite the claims put forth for the electric welding process in this connection.

* * *

Every flywheel acts in a measure like a fan, taking in air at the hub and discharging it at the rim. The current of air set up in this way is often disagreeable and sometimes injurious to processes of manufacture. In any case it means a waste of power which with a large wheel running at high speed may be a considerable item. A writer in *Power* recommends that all flywheels be encased, the casing being made a part of the wheel itself and not in the form of a box surrounding it. A box casing surrounding the wheel only partially reduces the loss of power and is not as easily and cheaply made as drumhead casings applied to the wheel itself. These casings may be made of canvas supported on radial wires, and segments of wood fitted in the rim and a wooden clamp collar at the hub. With this construction the air within the wheel revolves with it without escaping; with a box casing it is being continually agitated, the fanning action being only partially suppressed.

WILLIAM B. COGSWELL.

REPRESENTATIVE AMERICAN MECHANICS AND ENGINEERS.

William B. Cogswell, mechanical engineer and general manager of the Solvay Process Company and the Tully Pipe Line Co., Syracuse, N. Y., was born in Oswego, N. Y., September 22, 1834. From seven to ten years of age he attended the Hamilton Academy; he afterward attended a school kept by Joseph Allen of Syracuse, and also a school kept by Prof. Orin Root, in Seneca Falls, N. Y. During the two years, 1848-9, Mr. Cogswell worked with an engineering party on the survey of the Syracuse & Oswego R. R. and the Syracuse & Utica R. R. His natural tastes impelled him strongly toward engineering as a profession, and when his surveying experience ended, he entered the Rensselaer Polytechnic Institute, at Troy, N. Y., May 1, 1850, in the class of 1852. He remained three years but owing to an extension of the course no class was graduated in that year. In the year 1854 the degree of C. E. was conferred on him by this institute.

Soon after leaving the school Mr. Cogswell began an apprenticeship in the Lawrence machine shop, under the superintendence of John C. Hoadley. He came out of that apprenticeship three years later with a theoretical and practical education in engineering, mechanics and physics with their allied branches, not often secured in so short a time by so young a man.

Returning to Syracuse in 1856 he was selected by George Barnes of the same city to assist him in taking charge of the machinery of the Marietta & Cincinnati R. R. at Chillicothe, of which road Mr. Barnes had been made superintendent. He remained in that position only three years when the railroad became crippled in the financial panic of 1857. The year 1859 Mr. Cogswell spent as superintendent of the Broadway Foundry in St. Louis, Mo., and in 1860 returned to Syracuse, and in conjunction with William A. and A. Avery Sweet, started the works which were the inception of the present Whitman & Barnes Manufacturing Co. Here the breaking out of the Civil War found him, and in 1861 he was appointed civil engineer in the United States Navy. In this position he performed an enormous amount of labor in fitting up separate repair shops for five stations on the Atlantic seaboard and lived at one of them erected on shipboard at Port Royal, S. C. In 1862 he was transferred to the Brooklyn Navy Yard and placed in charge of steam repairs where he remained four years. The following two years he lived in New York City. In 1870 he was called to take charge of the completion of the Clifton Suspension Bridge at Niagara Falls and at the same time gave his attention to the construction of two blast furnaces at the Franklin Iron Works in Oneida County, N. Y.

In 1874 he was solicited to go to Mine La Motte, in Missouri, to assume charge of the lead mines of the same name at that point. This mine was owned by Mr. Rowland Hazzard, who brought all arguments in his power to induce Mr. Cogswell to take this step. He remained there five years until the spring of 1879, when he decided to remove to Syracuse, although retaining the management of the Mine La Motte lead mines. After returning to Syracuse, and while in quest of some kind of employment, Mr. Cogswell decided on a step which has had a most important influence on Syracuse as it called into existence a new industry that has grown to great proportions. Through a friend he had made the acquaintance of Messrs. Solvay & Co., of Brussels, Belgium, who are the most prominent manufacturers in the soda industry in Europe, and he decided to go to Europe to investigate it. The result was that Mr. Cogswell was given a commission to inspect the various points in this country where a manufactory would be practicable, and report. After the receipt of the report steps were taken for the formation of a company for the manufacture of the various soda products. It was decided that Syracuse was the best point for the works and they were located there, for it was believed by Mr. Cogswell that rock salt might be discovered in the vicinity. Several experimental borings were made in 1881 and 1883, but without success; but information was obtained which led to the experiments in Tully valley in 1888, and the discovery of two veins of rock salt, each about fifty feet thick, at a depth of 1,200 feet. The company now receive their entire supply from the Tully wells. The company also put in a plant of such capacity that a large quantity of saturated brine is sold to the salt manufacturers of Syracuse. This industry led to the formation of the Tully Pipe Line Company, for conveying brine from the wells to the works.

A branch of the Solvay Works at Syracuse has been built at Detroit, and the output of the two works has probably tripled in the last fourteen or fifteen years. (In 1892 the output was 75,000 tons soda ash; 20,000 tons caustic potash; and 6,000 tons bicarbonate of soda.) An organization known as the Semet-Solvay Company is a branch of the same organization in the coke industry, and it grew out of the demand for ammonia required by the Solvay Company in their business. This branch has extended until they have banks of ovens located in twelve or fifteen different cities in the country, and is in extent probably as great as the soda ash business itself. Other industries have been engrafted on the original industry of making soda ash which was the first to be started by Mr. Cogswell, and in the introduction of others he has been instrumental, and when his best judgment has been followed there have been few mistakes.

The Hannawa Falls power plant, where the Racket River two miles above Potsdam, St. Lawrence County, offered a favorable opportunity, Mr. Cogswell organized and mainly financed the company that erected. Electric power is furnished to Potsdam and Ogdensburg.

Mr. Cogswell has in his life made the most of favorable conditions; inherited a good constitution; was brought up as a gentleman; started young in civil engineering; had a good technical education; learned the machinist's trade in one of the best shops in the country; and has coupled with these advantages a wide experience, and an abundance of good common sense. He is a member of the American Society of Civil Engineers; a member of the American Society of Mining Engineers; a member of the American Society of Mechanical Engineers; a Fellow of the Geographical Society; a member of the Society for the Advancement of Science; a member of the Society of Chemical Industry of England; and president of Warner's Portland Cement Company.

For the foregoing we are indebted to Memorial History of Syracuse published in 1891, and for later information to Prof. John E. Sweet, Syracuse, N. Y.

* * *

A movement inaugurated by Mr. Carnegie has resulted in the planning of a memorial building on the site of the birthplace of James Watt at Greenock, Scotland. The building will contain classrooms for the study of navigation and marine engineering, together with facilities for taking astronomical observations. Mr. Carnegie will bear a large part of the cost of this undertaking.

Entered at the Post-Office in New York City as Second-Class Mail Matter.

RAILWAY MACHINERY

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We solicit communications from practical men on subjects pertaining to railway machine shop practice, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

SEPTEMBER, 1906.

We are informed by Wilhelm Schmidt, the inventor of the Schmidt locomotive superheater, that 1,150 locomotives (in use on forty-five railroads) have been fitted with his type of superheater up to June, 1900. The Prussian railroads have agreed to pay him a royalty on at least 1,200 locomotives within six years and during the past year have ordered 420 superheater locomotives.

* * *

A note in the *Engineering News* gives the length of the greatest stretch of straight railroad track in the world as 65 miles, placing its location in the pampas of the Argentine Republic. A correspondent of a Los Angeles paper gives 175 miles as the length of a tangent track in the Argentine Republic, and states that the character of the ground would have permitted the road to continue for thirty miles further.

* * *

A news report states that the New York Central authorities expect to have the main line of that road out of New York operating with electric traction by October 15th of this year. On July 20th tests were made of two electric locomotives furnished by the General Electric Co. for this installation. A train was made up composed of one of these locomotives, a steel motor car designed for suburban service, and a steam locomotive. The make-up of this train allowed comparative tests to be made of each of these three forms of motive power, which were tried alternately. So far as ease of operation, handling, and rapidity in starting and stopping the train were concerned, the electric locomotive is said to have easily distanced its older rival. The announced present intention of the New York Central Railroad is to employ electric locomotives for all trains between Grand Central station and Croton, a distance of 35 miles north, where steam locomotives will be attached to the trains for the remainder of the journey to Albany. Meanwhile the third rail equipment is being hastened on other branch roads of this line.

* * *

One of the pressing troubles of railroading is that terminal facilities have not kept up with the growth of the locomotive. Roundhouses are too small, switches are inadequate, and turntables are notoriously too short for handling modern locomotives of the heaviest type. The expedients resorted to for turning long locomotives on short turntables are of a more or less varied nature; the one used by the Erie R.R. at the Jersey City terminal is quite novel. This turntable, by the way, is electrically operated, the feed wires being connected trolley-wire fashion to a pivot mounted on a bridge over the center of the table. The table is lengthened out for long locomotives by two rails tapering to wedge points at one end and supplied with clamps or stays which slip over the turntable rails; the rails stand at a slight angle above the turntable rails when in place. The locomotive is backed on from the opposite end and one pair of wheels of the tender truck runs upon the inclined rails sufficiently to clear the rails of the surrounding tracks. In this way a locomotive three feet or more longer than the turntable is handled after a fashion, and the expedient may be a hint to other railway terminals troubled with locomotives "too long for the bed."

* * *

LARGE LOCOMOTIVES.

In the course of a paper read by Mr. G. M. Basford before the Pacific Railway Club, February 17, 1906, mention was made of the surprising growth of the locomotive within the last twenty years. In 1888 Mr. M. N. Forney stated that in the previous thirty years the size and weight of passenger locomotives had doubled and a total weight of 100,000 pounds had been reached. He asked the question: "Will this rate of increase continue and in another twenty years, or 1918, will there be passenger engines running which will weigh 200,000 pounds and over?" The answer is that with twelve years yet to come we now have passenger locomotives weighing 236,200 pounds, having tenders weighing 163,000 pounds alone. In October, 1898, the large consolidation locomotives built for the Union Railway by the Pittsburg Locomotive Works were announced as the heaviest locomotives of the time. They weighed 230,000 pounds, but the Lake Shore Prairie type locomotive built by the American Locomotive Co. at the Brooks works in 1905 weighed 236,200 pounds, or more than the "enormous consolidation locomotives" of only six years ago.

Mr. William Forsyth, in an article published in June, 1900, predicted that in 1905 freight locomotives would have a tractive power of 70,000 pounds, and that the weight on the drivers would reach 280,000 pounds, with a total weight of 311,000 pounds; that the heating surface would be fully 4,000 square feet. The Mallet articulated compound locomotive built for the Baltimore & Ohio Railroad a year before the date mentioned by Mr. Forsyth has a total weight of 334,500 pounds and a total heating surface of 5,585 square feet. The point to be made is, of course, that the growth of the locomotive has exceeded the most sanguine dreams of men who were well qualified by reason of their experience to anticipate in some measure what the probable growth of the locomotive would be. The growth has been so rapid that it has outstripped the facilities of the roundhouses, terminal facilities, turntables and all other facilities of the railroad built for the accommodation of smaller motive power, and these limitations have been largely responsible for the so-called failures of the big locomotive. In regard to increased capacity, the tendency now seems to be to increase the boiler capacity rather than the tractive power. There are those who believe that the next advance in boiler power should take the form of boiler capacity without increasing the weight on the driving wheels. Greater boiler capacity would mean that trains could be handled at greater speed, although the tractive power for starting and accelerating would not be greater than heretofore.

* * *

A Western correspondent sends us a clipping from a local Iowa newspaper describing an oil burning motor passenger car recently put in service on the C. B. & Q. R. R. It is of interest to know that this engine is "160 pounds horse power," but its chief interest to railroad men is that nothing comes out of the stack of this engine, except the exhaust. Judging from the character of the article, we think that considerable "hot air" came from some source; but perhaps the engine differs from the reporter in that it provides for the consumption of its own product, while the reporter has to inflict his on the unfortunate public.

"The boiler of the engine has a capacity of 170 pounds of steam and is 160 pounds horsepower. The boiler is fed from a large water tank under the combination passenger and baggage car, which is built on the engine, having a capacity of 650 gallons of water. Next to the water tank is a large oil tank with a capacity of 110 gallons. Leading from the tank are pipes which carry the oil to the fire, hundreds of small burners having been placed in the interior of the fire box. That the burning of oil is much cheaper than coal is shown by the fact that but two gallons of the fluid are used to every mile, it being necessary to fill the tank at the end of every fifty miles. There is no smoke, nothing but the exhaust coming from the stack of the engine.

THE RATIONALE OF INDUSTRIAL BETTERMENT.

The editor of MACHINERY in a recent letter to the writer stated: "I find that while nearly all manufacturers with whom I have talked on the subject are entirely in accord with the efforts now being made to provide better surroundings for their operatives, some of them object to the introduction of social features in works management. The objection raised to these features is that they are liable to be construed as a form of paternalism which workmen strenuously object to. Perhaps I cannot do better than to quote the following opinion from a well-known manufacturer:

"'We do not believe that it helps a man to give him something for nothing, and we do not believe that he wants it. We have seen in a great many instances throughout the country where various plans of this kind have been tried, that men rather resent it and look upon it as a charity which is not desired. We believe in giving a man a chance to earn his recreations rather than provide them for him gratis, and we feel that all plans worked out on a basis of giving a man something for nothing are bound to fail, for the very reason that it can be nothing other than more or less of a charitable distribution, and that the American workman is above anything of this nature.'

"It seems to me that it is at this point where manufacturers frequently make a mistake, and any assistance that you can give to such of our readers as are looking into the subject will be appreciated, and I believe there is a chance that it will do a great deal of good."

The fact that the editor of MACHINERY feels that I can, from my experience in this new field of endeavor, be of assistance to the readers of his valued paper, who, I am glad to know, are interested in the subject, encourages me to seize the opportunity thus offered to meet the issue which is raised by the manufacturer above quoted, for, I feel that there are some who, like the latter, have a misunderstanding of the object of the features referred to, and there are also some, who, like those of whom he writes do not understand at all what these features mean. Before touching upon the phase of the subject which is here alluded to, let me for a moment consider the origin of the general movement in which it is involved.

Somewhat more than a quarter of a century ago the German government, impelled by paternalistic motives characteristic of its monarchial system, introduced into some of its subsidized industrial establishments certain features which were intended solely to improve the condition of the workers. These were appropriately termed Wohlfahrt's Einrichtunden, or "welfare institutions." These features, consisting of lunch rooms, rest rooms, libraries, emergency hospitals, gymnasiums, athletic grounds vegetable gardens, and the like, had been tried by certain manufacturers in England and elsewhere who were altruistic in their nature and co-operative in their beliefs. American manufacturers, driven by the fierce competition of the times to adopt every possible means of increasing the efficiency of their plants, were traveling abroad to study foreign industrial methods, and seeing these "institutions," were at once impressed not only with their novelty but with the improvement in the general prosperity of the enterprises in which they had been introduced. They saw at once that these improved conditions were attracting a better class of operatives, that the latter were doing more and better work, and that this resultant high-grade product was obtaining higher prices in the market. Impressed with the idea that there were economic principles involved in these features which they could not afford to ignore, they carefully investigated them, and on their return home proceeded to try them out under conditions as they existed in their own establishments.

It soon became apparent that fundamentally these institutions were not only ethical, but economic. That the so-called enlightened selfishness exemplified in the Golden Rule pays its possessor many fold.

It was evident that the better the operatives were housed and fed, and the better their habits were outside of working hours, the better would be their general physical condition and the more regular would be their attendance; that the higher their mental attainments the more intelligently they would conserve their strength and apply their knowledge and skill and the business would thereby be improved and the profits increased.

It became evident, however, that the democratic tendencies of American workmen would not allow these features to be applied in the paternalistic manner adopted by the German manufacturers. Our people had been brought up to be independent and self-reliant, and resented having forced upon them anything which savored of charity. Now, manufacturers had long learned that machines represent capital invested and that the only time this investment is earning interest is when the machines are running and turning out product to be sold, so that any means that could be adopted that would tend to keep the machines continuously productive and at the same time insure high grade of product, would raise the interest on the investment. They soon realized that these features which they were investigating were productive of exactly what they were desirous of accomplishing, and they lost no time in introducing them in their establishments with such modifications as they found were necessary in transplanting foreign institutions to new soil.

The remarkable results which attended the intelligent installation of these features, which were given the appropriate appellation of "Industrial Betterment" led other manufacturers to their adoption, but many of the latter, not realizing their fundamental object, applied them indiscriminately and scored failures. They seemed to think the motive was essentially altruistic and adopted paternal methods of applying them, calling them "welfare work" and arousing well-merited resentment. The correspondent to whom the editor refers says rightly that there are "a great many instances throughout the country where various plans of this kind have been tried" which have not met with success, but these failures have been due to a lack of understanding of the purport of the installation and accompanied by ignorance of the proper method of its introduction. He, himself, misunderstands the purport of the movement and cannot see the benefits which have accrued in those other instances where the installation of these features has been a great success. The term "welfare work" has misled him.

There are plenty of men who mistake the substance for the essence who "cannot see the forest for the trees." There is no "welfare work" about it. It is "Industrial Betterment."

It is efficiency of organization that the modern business man is anxious to secure, and this can be obtained by "Industrial Betterment" intelligently installed. This is no longer in the experimental stage; it has too often proved successful, and the manufacturer who delays its adoption is simply closing his eyes to the advance of the times and to one of the most potent means of promoting his own interests.

H. F. J. PORTER.

* * *

The novelty of an invention very often consists in the recognition of a want rather than in the specific form in which this want is satisfied. Many of us go through life knowing in a vague way that certain ways of doing things are not quite satisfactory, but when some one recognizes this fact and provides a tool or device which accomplishes the work much more easily and satisfactorily than before, we are all prone to wonder why we had not thought of the same thing ourselves. The point is, that when the need was fully recognized the tool or device necessary for forming the required work was a comparatively simple accomplishment. The need of some devices, however, is so obvious and has been recognized by so many people that thousands of inventions have been devised to fill the want, as, for example, the car coupler and the non-refilling bottle. To make the business of inventing pay, the inventor must, in general, recognize a need before others do.

* * *

The use of opaque or ground glass for the lower sections of shop windows is often desirable, but it is not advisable unless the interior has a clear unobstructed view in some direction of, say, one hundred feet. The reason is that men working on anything requiring close attention of the eyes are likely to suffer from eye-strain if they cannot occasionally relieve the strain by focussing them on some distant object, and this cannot be done in a small room with opaque glass in the windows.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The *Engineering Record* reports the use of the electromagnet in recovering lost drill points at various places in Pennsylvania. At Greenburg a heavy point stuck at a depth of 250 feet in a well, but it was readily loosened and brought to the surface by an electromagnet.

It is reported that the Carnegie Steel Company will drill a well 6,000 feet deep in the gas field near Waynesburg, Pa. It will be done to test a theory that the gas sands now being developed are only the top or secondary sands, and that the primary and principal producing sand strata will be found underlying it several thousand feet. The experiment is attracting considerable attention, not only because of the possible discoveries but for the special derrick and machinery required for drilling such a deep bore.

It is reported in *Page's Weekly* that there is a likelihood of a revision of the agreement entered into by the English Engineering Employers' Federation and Amalgamated Society of Engineers. This historic agreement was adopted after the great strike in 1897. The scope of the proposed changes may be indicated by three suggested amendments. One is that the Federation shall recommend the preferential employment of society men, instead of leaving firms to employ whom they choose, a freedom of management for which the federated employers sacrificed so much in 1897; another seeks to limit the number of apprentices; and a third asks that the maximum overtime shall be 20 hours per man per month, instead of 40 hours, as at present.

It is stated in the *Engineering Record* that in the survey of a new 14-foot water way between Chicago and St. Louis the leveling for a distance of 334 miles was done with a probable error for the whole length of only about 13.55 millimeters, or slightly over one-half an inch. The level was protected from the sun by one large umbrella, while another, held by a rod stuck in the ground, cut off the wind. When the immense distance covered is considered, the error is so slight that the instrument used ranks in accuracy with the finest tools employed in machine shop measurements. It is quite possible that the transit as employed to some extent by the Westinghouse Electric and Mfg. Co. and others, deserves a larger field of usefulness in the machine building business.

The United States Consul at Venice says that some of the high-power motors in the Monte Carlo races had a universal joint in the shaft, between the motor and the thrust bearing, so that the possible deviation of the shaft from a straight line, through vibration, or the straining of the boat, would not affect materially the running of the motor. This feature is believed to be valuable even on the smaller boats. Another feature of interest was the seemingly exaggerated precautions against eddies, such, for example, as tapering the end of the shaft to a point beyond the propeller, and also the knife-edge of the stem. In a series of experiments made last year by a Scotch designer, the difference in the fineness of the stems of ships has been shown to influence their speed very materially, and this seems to have been taken into account in the construction of the racing boats of this year.

There has long been a demand for some arrangement by which the amount of material remaining in a bolt of ribbon or cloth can be ascertained at a glance. As a means of doing this the suggestion was made that a tape be wound up with the ribbon, the tape being marked with inches, feet and yards, but when this was tried, it was found that there was a serious discrepancy in the respective lengths of the two pieces. This difficulty has now been overcome by slitting the paper tape at regular intervals, and passing the ribbon in and out through these slits. This innovation, which is the invention of a Chicago ribbon manufacturer, will not only be of great assistance in the shop, where the ribbon may be measured off in the required quantities without the use of a yard-stick, but will be also found to greatly facilitate the work of stock taking, which in the case of ribbons, cloths, and similar materials is a very tedious operation.—*Scientific American.*

In connection with the recent launching of the *Lusitania*, *Engineering*, of London, gives some figures showing the total tonnage of the recent launches on the river Clyde. The month of June, 1906, will long be remembered for its record in this respect, the total being 124,544 tons, which is very much greater than the figures for any previous month. This great increase is of course accounted for by the coincidence that the Cunard liner *Lusitania* and the battleship *Agamemnon* both happened to be ready for launching about the same time. Without these two larger vessels, however, the other 34 craft make the very respectable aggregate of 75,544 tons. The total for the last six months stands at 335,258 tons, a record which probably will not be surpassed for some time to come, as new contracts are not being placed so rapidly now as they were two or three years ago.

A correspondent of the *London Times* in the engineering supplement of that journal states that what is believed to be the largest and heaviest lathe yet built has recently been furnished by Messrs. Hulse & Co., of Mancheser, England, to the shipbuilding firm of Messrs. R. & W. Hawthorne, Leslie & Co., of New Castle-on-Tyne. This lathe is to be used in machining the rotor and other parts of the steam turbines which are building for the Cunard express steamer *Mauritania*, sister ship of the *Lusitania.* It will take work up to 16 feet in diameter over the carriage or 18 feet over the ways if the work is held on the faceplate. The bed is 18 feet wide by 68½ feet long and work 50 feet in length may be held between the centers. The machine is operated from platforms, and short ladders are necessary to enable the workman to mount the platform from the level of the bed. While longer lathes have been built for such work as gun turning and boring, and lathes of larger swing have been built for turning flywheels and other such work, it is doubtful if a larger lathe for general purposes has ever been built.

A commercial combination of a peculiar character is reported from England. The firms manufacturing coal cutting machinery have been troubled by colliery owners who have asked to have machinery put to work in their mines on trial. Owing to the competition in this class of machinery the builders have been forced to do this. The mine owners have taken advantage of this competition and have lengthened the trial period by all means possible from month to month, thus getting extended service from the machinery without having to go to the trouble of purchasing it. When they could no longer use them free, many of them have sought to enter into arrangements whereby they could rent the machines for a comparatively low price. This has also proved unprofitable from the manufacturer's standpoint, since rented machinery is very naturally used much harder and is less well-cared for than that which is owned by the users. The new combination is based on an agreement of the builders of coal cutting machinery to refuse to rent their product and to refuse trial of the machines except under certain definite restrictions.

The *Engineering Record* reports some tests of steel at low temperatures made during the past year at the Watertown Arsenal in Massachusetts. The steels tested varied in quality from 0.16 to 1.09 per cent carbon. The elastic limit of the steel in one of the bars was 80,000 pounds per square inch, with an elongation of 10.7 per cent at the low temperature of the liquid air. A similar specimen tested at a room temperature of 76 deg. Fahr. showed an elastic limit of 52,800 pounds per square inch, an elongation of 29.3 per cent, the effect of the very low temperature being to increase the elastic limit of the steel 51 per cent, while the ultimate strength of the steel was raised to 97,600 pounds per square inch, or 35 per

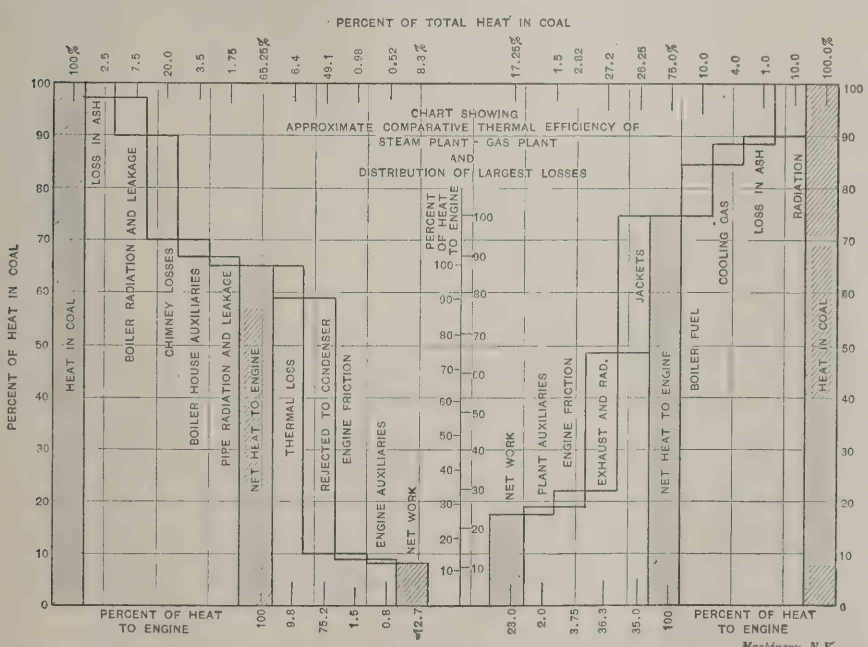
cent above the ultimate strength at ordinary temperatures. The results of these experiments are similar to those that have been obtained by numerous other experimenters, who have investigated the properties of steel under the same conditions, in that it is shown that a great increase is produced in the tensile strength of steel at low temperatures, with a corresponding decrease in ductility.

THE ACTION OF THE CAPPED SHELL.

There is something mysterious in the action of the well-known soft metal cap for armor piercing shells, such as was illustrated in the article on projectile manufacture in the August issue. Perhaps the most commonly accepted theory to account for its effectiveness is that which considers it as melting at the instant of impact, and acting as a lubricant for the nose of the shell during its passage through the armor. This idea is untenable, however, since it would hold true in the case of penetration of soft armor only, and not in the case of hardened steel where the metal is cracked and shattered. In reality the device is more effective when piercing hardened materials than it is for softer ones. An army officer contributes to the *Journal of the United States Artillery* a translation of a paper read by a German engineer, who ascribes the effect to a different cause. He considers it to be due to the fact that the point of the projectile is by this means saved from deformation at the instant of the impact. The mass of soft metal in which it is imbedded acts as a cushion and distributes the pressure over a fairly large cross section, instead of allowing it to concentrate on the point, which it would otherwise fracture. This point is thus preserved to act as an effective chisel in piercing through the hardened outer layer of the armor plate; the wedge shaped body of the projectile following, serves to increase the opening thus effected.

RELATIVE ECONOMY OF STEAM AND GAS ENGINES.

At the recent meeting of the Ohio Society of Mechanical Engineers, Mr. J. R. Bibbins presented a paper on "Gas Engines in Commercial Service," which was accompanied by a chart that showed very clearly the comparative economy of steam and gas engines, in so far as fuel is concerned. This chart is presented herewith. The performance of the steam



Comparative Efficiency of Gas and Steam Power Plants.

engine, from the coal pile to the work done is shown on the left side, and the performance of a producer gas engine on the right side. In reference to this chart, Mr. Bibbins says:

"In the accompanying chart the writer has attempted to make an approximate distribution of losses in various parts of the plant, based upon observations from numerous sources on each of its component parts. It is believed that the estimates are not unduly partial to either a gas or steam plant of moderate size.

"Starting with the heat in a fair grade of steam coal, 13,500 British thermal units per pound, we find 35 per cent of this heat dissipated in the boiler plant and piping system, and 25 per cent in the producer plant. Fifty-seven per cent is, however, dissipated in a steam engine, and approximately the same in the gas engine, leaving 8⅛ per cent net output for the steam plant and 17¼ per cent for the gas plant. Thus on a heat basis, gas is twice as efficient as steam. Part of the advantage lies in the more efficient converting properties of the producer and the remainder in the higher thermal efficiency of the gas engine. In natural gas plants where no producers are necessary there is, of course, no question as to the superior economy of gas.

"Granted the superior economy of the gas plant, it is also necessary to take into account not only operating costs, but investment costs or fixed charges to arrive at a proper conclusion. Without going into this economic problem here, it is sufficient to say that plants of a few hundred kilowatts capacity may quite possibly cost more per kilowatt than a steam plant of corresponding size and character, but the saving in the operating expenses will soon wipe out the excess cost and eventually put steam 'out of the running.'" W. B. Jr.

ACETYLENE GAS FOR WELDING.

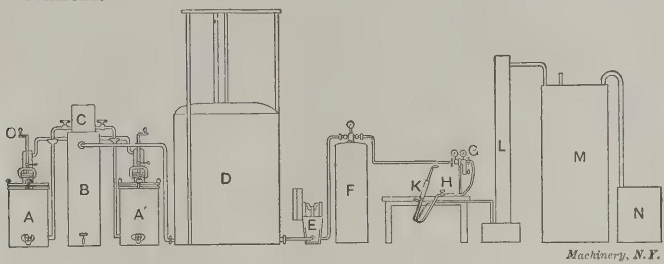
Under the heading "Autogenous Welding of Metals by the Oxy-acetylene Blowpipe," M. Andre Beltzer gives a description and illustration of apparatus for this process in the *Electrochemical and Metallurgical Industry.* The oxy-hydrogen blowpipe has been used for this purpose, but is expensive and unsatisfactory, where much heat or high temperature is required. Acetylene gas is more suitable on account of being cheaper, and also because the temperature of the flame is much greater, being about 6300 degrees F., while that of hydrogen is about 3600 degrees F. The obstacle that has stood in the way of using the acetylene blowpipe has been the high price of oxygen. M. Beltzer states, however, that oxygen can now be obtained at a reasonable price by the use of a newly-discovered product called "epurite." This substance contains oxygen in a latent form which can be easily liberated by contact with water, the same as acetylene is obtained from calcium carbide. When oxygen is obtained by this process, not only is the cost reduced to a reasonable point, but all danger of explosions arising from the use of gas confined under high pressure in tanks is removed. An oxy-acetylene blowpipe welding outfit provided with an "epurite" oxygen generator is illustrated diagrammatically on the following page.

One of the oxygen generators *A* is charged with water and epurite. In the receptacle *C* is a solution of sulphate of iron, which is allowed to flow into the generator to act as a catalytic agent for the generation of oxygen. The oxygen liberated passes into the gasometer *D*, and is compressed to 10 atmospheres by the compressor *E* in the tank *F*. From the tank the gas passes by a tube through the pressure regulator *G* and valve *H* to the blowpipe *K*, where the oxygen should arrive at a pressure of 60 inches water. The acetylene apparatus *N M* is arranged so as to give the gas at the above pressure. This pressure of 60 inches water is calculated so that the exit speed of the gas will counteract the possible back burning of the mixture before reaching the end of the blowpipe.

The blowpipe is provided with metallic gauzes to prevent the flame throwing back. The valve of the acetylene tube (fixed to the blowpipe) is at first turned on full, the pressure regulator being adjusted to about a one-half atmosphere. The flow of oxygen is controlled by a valve *H*, so that there is only one inner cone in the flame which will have only slight fluctuations. The flame now is neutral and ready for use.

A whiter color of the flame and the division of the inner

cone in two are indications that there is an excess of acetylene gas, and that the flame is carbureting, the molten metal emitting sparks like stars (formation of cast iron). When the flame is oxydizing (shown by the violet tint of the flame) the metal boils and is very bright. For proper welding (steel sheets, for instance,) the joint should be bright. The carbureting flame gives a gray porous and non-resistant welding. This flame, together with an oxydizing flame, gives a brittle welding, and is, moreover, very rarely used. Twenty different sizes of nozzles can be used on the same blowpipe in welding of all thicknesses, from 0.04 to 1¼ inch thick (0.024 inch for sheets 0.04 inch thick, and 0.16 inch for sheets 1¼ inch in thickness.



Apparatus Required for Welding with Acetylene.

During the process of welding, the apex of the cone must be from 0.08 to 0.12 inch distant from the object to be welded. The two edges (previously dressed) are fused, and simultaneously lined and slightly overloaded by the fusing of a rod of the same metal held in the flame. In this manner iron, steel, copper, brass, cast iron, etc., can be effectively welded. For thick metals or plates it is necessary to bevel the edges, which can be readily done by many mechanical methods.

For brass it is necessary to fill up the interstices of the two sheets to be welded with borax moistened with water, otherwise the volatilized zinc would be deposited on the welded part as oxide of zinc and spoil the welding.

From tests made by the International Bureau Veritas, in Paris, it has been found that the tensile strength of welds made by this process is within 5 per cent of that of the metal itself. The cost of the process for sheet metal work is less than riveting for thickness under about five-sixteenths of an inch.

W. B. Jr.

IMPACT TESTING MACHINE.

In testing metals to determine their resistance to impact, two methods are commonly used. One is to strike a single blow strong enough to bend or break the test piece; the other is to strike numerous light blows and ascertain the number required to produce fracture or actual breakage of the specimen. The latter method is the most desirable because it gives the strength of the metal when subject to the conditions it has to meet in practice. When the test piece is struck many blows, it is necessary to rotate it through half a turn at each blow so that it may be bent or sprung back and forth with the successive blows. If this rotating is done by hand it takes considerable time, so that only a comparatively small number of blows can be struck, five or six hundred. For the purpose of conducting certain impact tests, the National Physical Laboratory of England has had designed and made a machine in which the test piece is turned through 180 degrees at each blow automatically. This machine strikes about forty-five blows per minute, which are recorded by means of a registering apparatus attached to the shaft. The construction and operation of the machine can be understood from Figs. 1, 2, and 3, together with the following description, which we reproduce from *Engineering:*

The hammer, *A*, is provided with a hardened-steel shoe where it comes into contact with the specimen, and two side-rods passing through the base-plate and terminated by a cross-head, *B*. The cross-head is fitted with a small roller for engagement with the lifting cam, *C*, and with two conical rollers working in vertical guides, *D*, which take the hori-

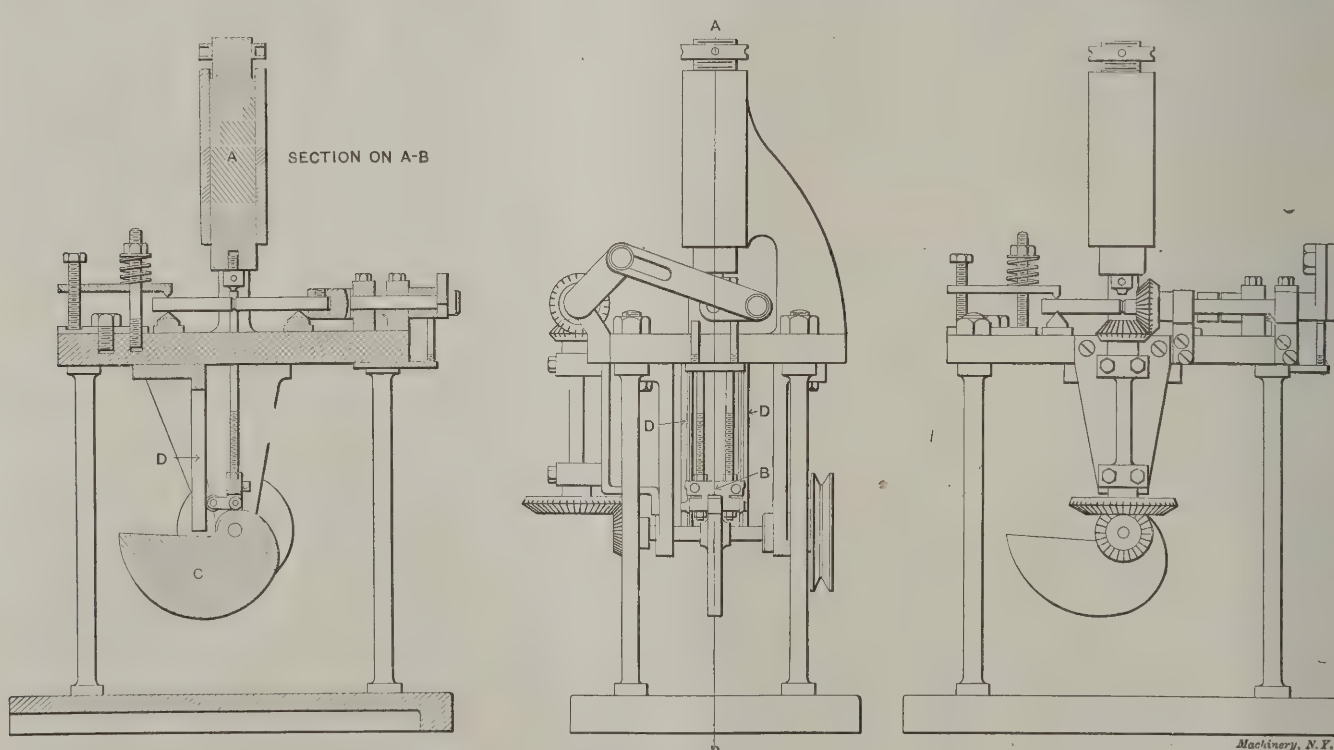


Fig 1. Fig 2 Fig 3.

An Impact Machine for Testing Steel Specimens.

Cast iron, which cannot be self-welded, must be brazed with copper.

One decided advantage of the oxy-acetylene flame over the oxy-hydrogen is, that it can be easily regulated by the workman, owing to its brightness. Another advantage is that the gases formed by the combustion are hydrogen and carbon oxide, which combine with the surrounding air, forming carbonic acid and water, thus protecting the molten metallic surfaces from the oxidizing action of the air,

zontal thrust of the cam. The side-rods are attached to the cross-head by lock-nuts, so that the fall of the striking hammer can be regulated from 0 inch to 3½ inches. The cam shaft makes approximately 45 revolutions per minute.

To rotate the specimen through 180 degrees between successive blows a link motion is employed, which is worked from a countershaft parallel to the specimen, and revolving at half the speed of the cam shaft. A second shaft, whose axis coincides with that of the specimen to which it is coupled,

receives its motion from the countershaft by means of the two cranks and slotted link shown in the figures. By correctly proportioning the length of the slot, it can be arranged so that when the motion of the crank on the countershaft is continuous, that of the crank on the second shaft is oscillatory through an angle of 180 degrees.

In order that the second shaft shall not interfere with the free vibrations of the specimen when struck, its attachment to the specimen is made by a semi-Oldham coupling, which is set so that the plane of its slot coincides with the plane of free vibration of the specimen. The knife-edges on which the specimen rests are made of V shape, so that there is no tendency for the specimen to move sideways. The specimens are ½ inch in diameter, the knife-edges being 4½ inches apart. The diameter at the bottom of the notch is 0.4 inch.

If the fall of the hammer is adjusted so that the specimen will bear not less than, approximately, two thousand blows before fracture, there is no appreciable permanent set in the specimen until a comparatively short time from the ultimate fracture. The manner of failure of the specimens, whether of soft or hard material, is that a crack is developed on each side of the specimen in the plane of the notch, the two cracks proceeding inwards as the test proceeds.

The machine seems likely to be of considerable service in the impact tests of mild steels which cannot be broken, even when notched, by the single-blow bending method. The following is an example of a set of tests made on a sample of mild steel:

Fall of Striking Hammer in inches.	Energy of Blow in inch-pounds.	Number of Blows for Fracture.
0.77	3.62	4,950
0.50	2.85	12,400
0.30	1.41	44,634

W. B., Jr.

NEW GERMAN TURBINE.

The *Gesellschaft für Elektrische Industrie*, of Carlsrube, in Baden, Germany, has brought out a type of steam turbine which, while not new in principle, is different from the design that is almost universally used, at least by the large manufacturers. This turbine is shown in Figs. 1, 2 and 3, the first being a vertical section at right angles to the shaft, the second a vertical section parallel with the shaft, and the third a perspective view of the wheel. As will be seen from Fig. 1, this is a four-stage turbine, in which the stages are obtained

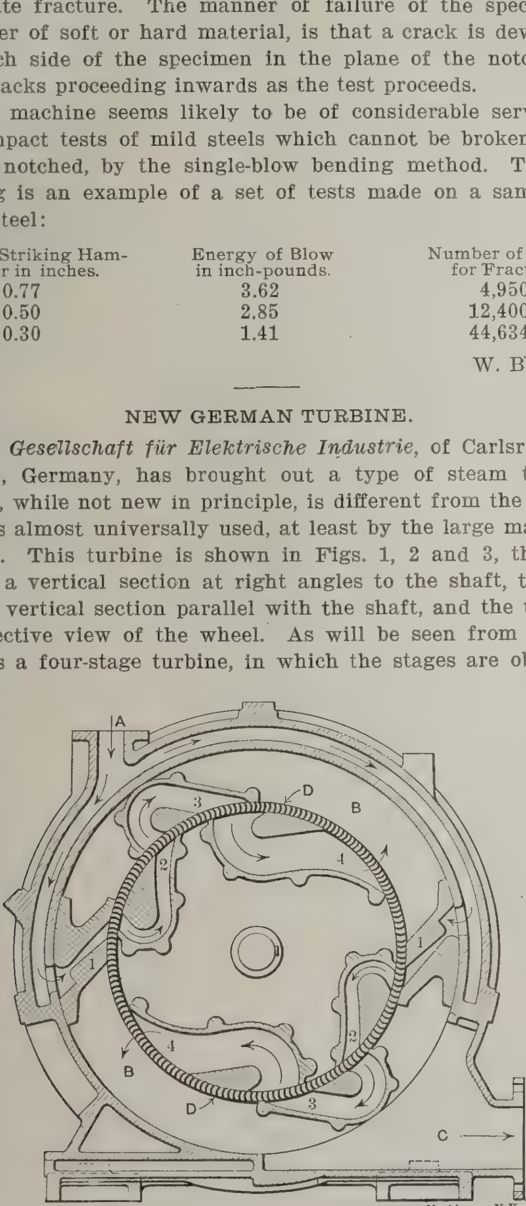


Fig. 1. Cross-section of a German Steam Turbine.

by passing the steam through the buckets of the wheel four times. Steam enters at A and passes from nozzles 1 through the wheel buckets to nozzles 2, thence through the wheel a second time to nozzles 3, and a third time through the wheel to nozzles 4; the fourth passage through the wheel carrying the steam to the spaces B, from whence it passes to the exhaust pipe C. When we consider that in the designs in which each stage requires one wheel, the first few wheels do not utilize more than a small portion of the periphery, we can easily see that the construction here shown should afford the means of producing a decidedly compact machine, and probably at a lower cost than the multi-wheel type. On account of the compact construction, this turbine should be well adapted to launches. Fig. 2 shows a reversible boat turbine. It is made with a wheel having buckets on both sides, the

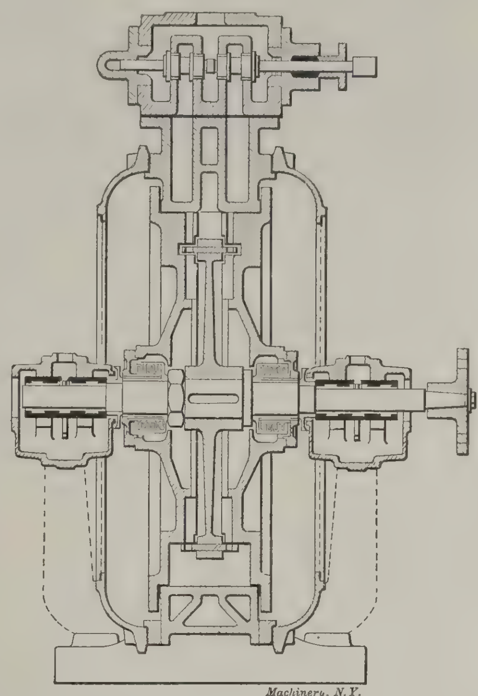


Fig. 2. Arrangement of Reversible Marine Turbine.

buckets and nozzles on one side running in the opposite direction of those on the other side. By means of the valve seen above the turbine casing, the steam can be directed to either side to produce rotation in whichever direction is desired.

W. B. Jr.

OLD STEAM ENGINE AT THE VERSAILLES WATER WORKS.

Revue de Mecanique, May 31, 1906.

In the early part of the nineteenth century when the reconstruction of the pumping station for the Versailles water works was under consideration it was proposed that a steam engine be substituted for the water wheels previously used. The matter was placed in the hands of a commission in 1811, but it was not until October 14, 1821, that the matter was settled and the foundation laid.

The installation included a steam engine and boiler as well as the cast-iron piping a foot in diameter. Like the majority of steam engines of the day, the machine that had been proposed by MHessrs. Cooke and Martin was of the beam type, working under a low pressure and condensing. The steam cylinder had a diameter of 42.6 inches and a stroke of 76.77 inches with a thickness of shell of 1.42 inch. It was fitted with a steam jacket, and the steam distribution was effected by means of two valves driven by an eccentric mounted on an intermediate shaft to which the main crank was attached at the end of the beam on the opposite side from the cylin-

Fig. 3. Construction of the Wheel and Blades.

der. This eccentric also, by means of a lever, drove the pump by which the boiler was fed.

The piston rod of the condenser air pump was attached to the beam on the same side as the steam cylinder. The obtain a gradual and uniform tightening of the packing, as seen in Fig. 2.

After having done its work in the cylinder, the steam passed by way of a cast-iron pipe to the hot well of the condenser,

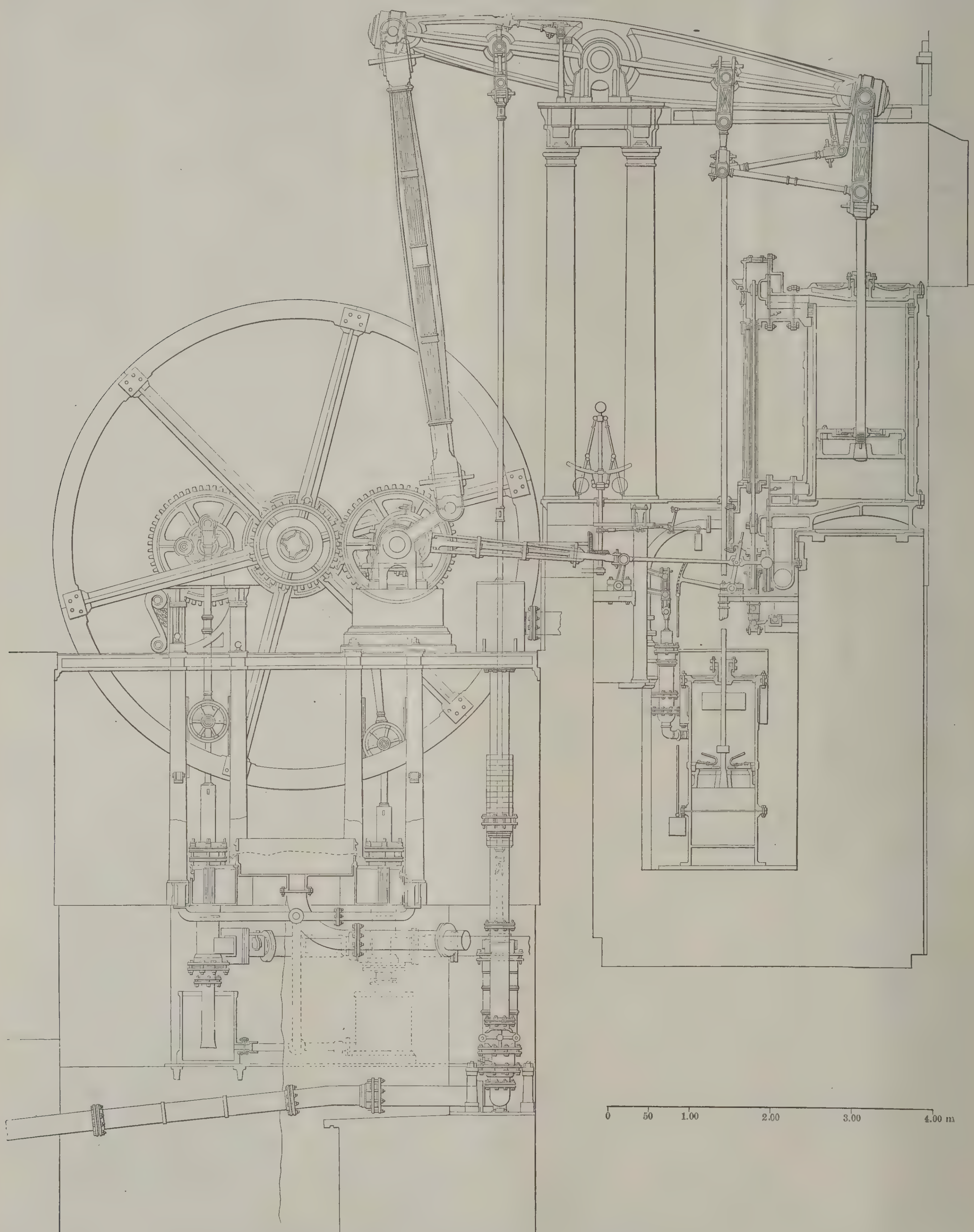


Fig. 1. Elevation of the Versailles Water Works Engine at Marley.

arrangement of the cylinder and the details of the valve mechanism are shown in the side elevation (Fig. 1) of the engine. It may be noted that the cover serving to form the joint of the piston was fitted with a toothed wheel so as to as shown in the side elevation and vertical section, Figs. 1 and 5. A jet of cold water was injected into this hot well and completed the condensing, the whole being encased in a large tank of cast iron, into which the water drawn from

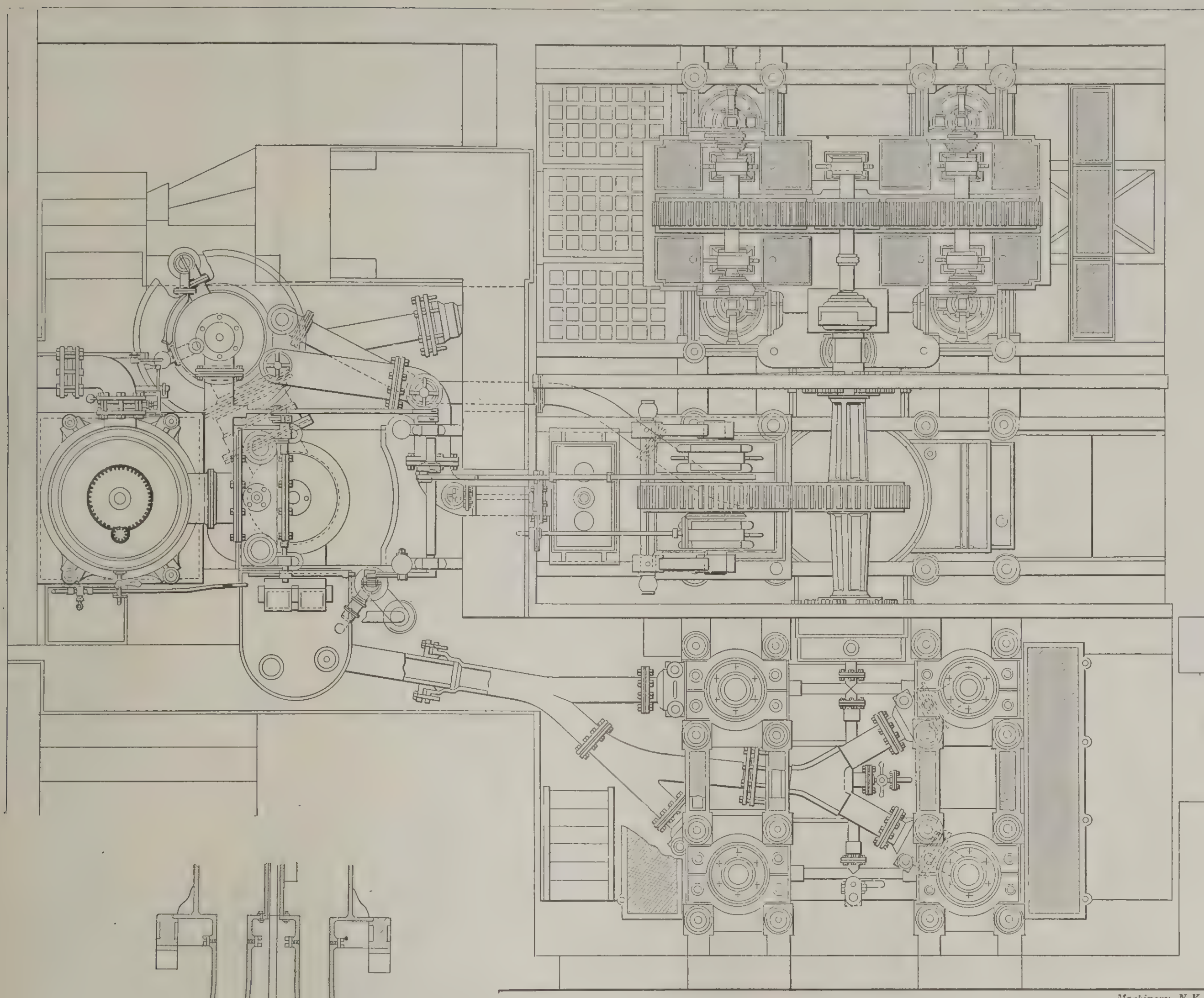


Fig. 2. Plan View of Pumping Engine.

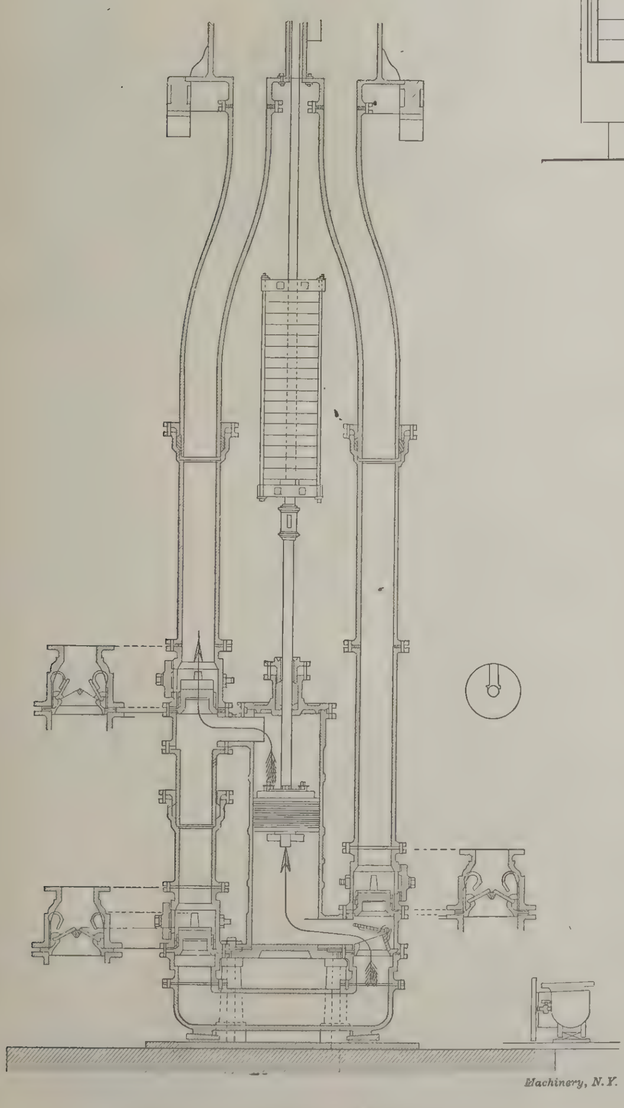


Fig. 3. Cross-section of Supply Pump.

the Seine went before entering the eight pump cylinders which forced it into the aqueduct.

The piston of the air pump is 29 inches in diameter, and delivers hot water into the tank which is to be seen at the left of the pump in Fig. 5, and from which the feed pump of the boilers also draws. The surplus of hot water which does not go to the boiler passes by a system of pipes to one of the cast-iron water tanks, located alongside the stairway of the approach to the building. All of this machinery, which is remarkable in its finish, was furnished by the Creusot shops. The trunnions of the beam are carried by four cast columns set upon a heavy masonry foundation, and an iron balustrade broken by monumental candelabra surrounds the steam engine.

The power of the cylinder was calculated to be sufficient to furnish 64 horsepower of 75 kilogrammeters per second at 14 revolutions or 14 double strokes a minute with a steam pressure of 4.5 inches of mercury or about 2 pounds per square inch. When working in this way, the engine was capable of raising 1,800 cubic meters (296,000 gallons) of water per day to the Louveciennes aqueduct. This work necessitates the consumption of about 10 tons of coal per day.

The two connecting rods fastened to the end of the beam drive cranks keyed to the ends of the first transmission shaft, which carries at its center a gear of 57 inches diameter. The eccentrics controlling the steam distribution are also keyed to this same shaft on either side of the gear. This latter meshes in with a second of 43.3 inches diameter, which is keyed to a second transmission shaft, which carries gears at each end driving a group of four pumps. On each side, between the central gear and those at the ends there is a large flywheel and a clutch coupling, so that either group of four pumps can be cut out if desired.

Each of the gears at the end of the second transmission shaft meshes with another of 57 inches in diameter, which is mounted

on the center of a shaft, at each end of which there is a crank driving a suction and force pump. Each shaft thus controls two pumps and as there are two groups of four pumps each, that forms the basis of the system.

The eight pumps just described do not draw directly from the river, but from cylinders placed directly beneath the body of the pump as shown in the side elevation, Fig. 1. These cylinders were fed from below by means of a system of piping starting from small cast-iron basins placed on a level with the upper part of the body of the pump. These basins were fitted with overflows and water-inch marks so that the amount of water which they delivered could be regulated according to the delivery of the force pumps, as shown in Figs. 1, 2 and 5.

The supply for the basins just mentioned was effected by means of a supply pump shown in detail in Fig. 3. This pump was driven by means of connecting rods attached to the beam of the engine and drew its water from the river through a pipe passing beneath the Saint Germain road. The delivery was effected through two columns fitted with bronze clap valves, and delivered into a rectangular cast-iron tank set above the pump, and slightly below the level of the transmission shaft. Cast-iron piping led from this tank to the envelope of the condenser.

From the envelope of the condenser a second system of piping led beneath the center of the cast-iron tank already mentioned. The water, after having reached the center of this cast-iron reservoir, went into three settling tanks, from which it flowed as previously stated, to the suction tank set beneath the force pumps.

This engine which was not finished until 1825, was run for the first time on July 20, but only for a moment, because of the breaking of the teeth of the gear driving the pump shafts. Trials were made the following year on February 15, March 5, April 17, August 5, and September 5 but it was not until May 5, 1827, that the engine was set regularly at work.

The following are the best results that could be obtained with this engine in the course of some accurate tests made in 1851, many years after it had been completed and after a number of improvements had been made:

Steam pressure	15 inches of mercury (7½ pounds.
Vacuum in condenser	25 inches.
Speed	16 revolutions per minute.
Power in cylinder	95 horsepower.
Water raised per day	548,670 gallons.
Power in water raised	50 horsepower.
Anzin coal consumption per hour	917.4 pounds.
Heating surface of boilers	343 square feet.

The boilers had a firebrick furnace set beneath a cylindrical shell 6 feet 9 inches in diameter and 9 feet long. These boilers were replaced ten years later by others having fire tubes inside and so arranged as to give the flames a triple circulation.

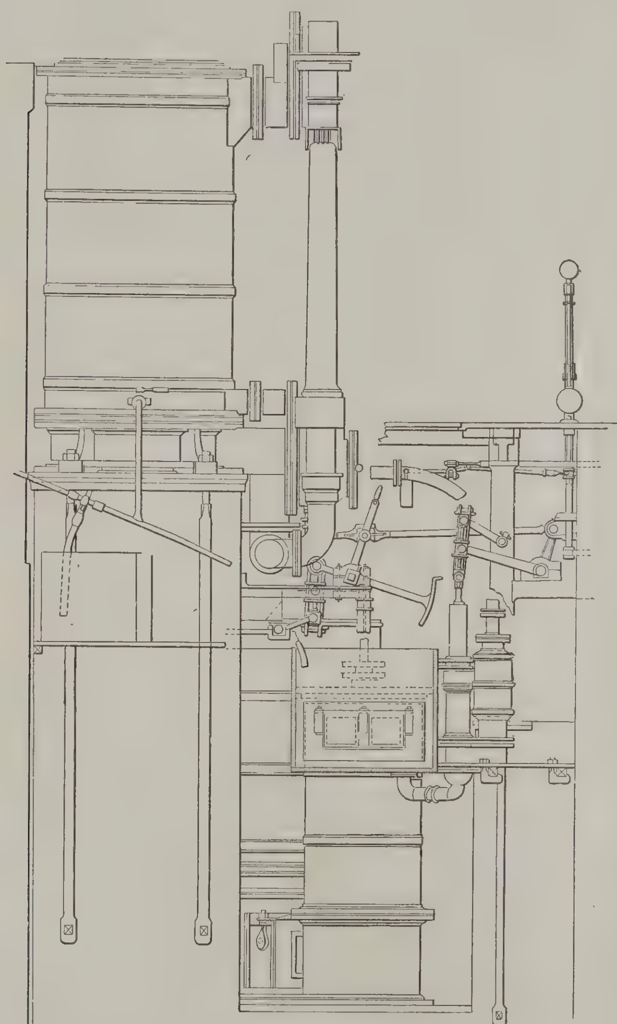


Fig. 4. Elevation of Condenser and Valve Mechanism.

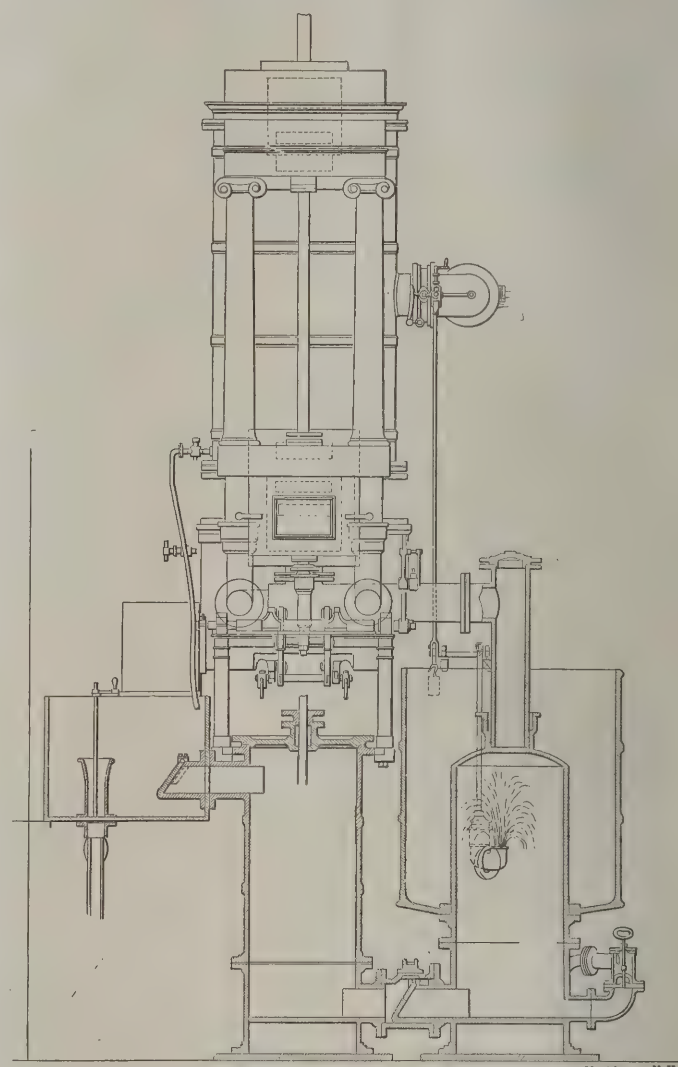


Fig. 5. Section through Condenser and Air Pump.

It appears that this engine was run for the last time on June 9, 1859, and it was removed between 1900 and 1905 to give place to the Barbet and Hersent engines, but the building in which it was housed has been preserved.

According to a report of M. Usquin, rendered in 1837, this steam engine cost more than 3,000,000 francs ($600,000), inclusive of the piping and the location of the same. It burned about 250 bushels of coal on a day's run and the cost of maintenance for the whole plant at Marly amounted to about 130,000 francs ($26,000) per year. In this report the author pointed out the deplorable condition of the maintenance of the dam intended to keep the waters of the Seine in the bay of the machine. "The result is," he said, "that the water does not flow directly into the bay, so that, when it is low, only a small amount of water comes beneath the Marly

wheels and cannot give them the power that they were intended to have." It must not be forgotten, however, that these two wheels formed a supplementary machine, set up, according to this author, to be run during the construction of the steam engine, and that, under the circumstances, the manager of the works would have been in an awkward posi-

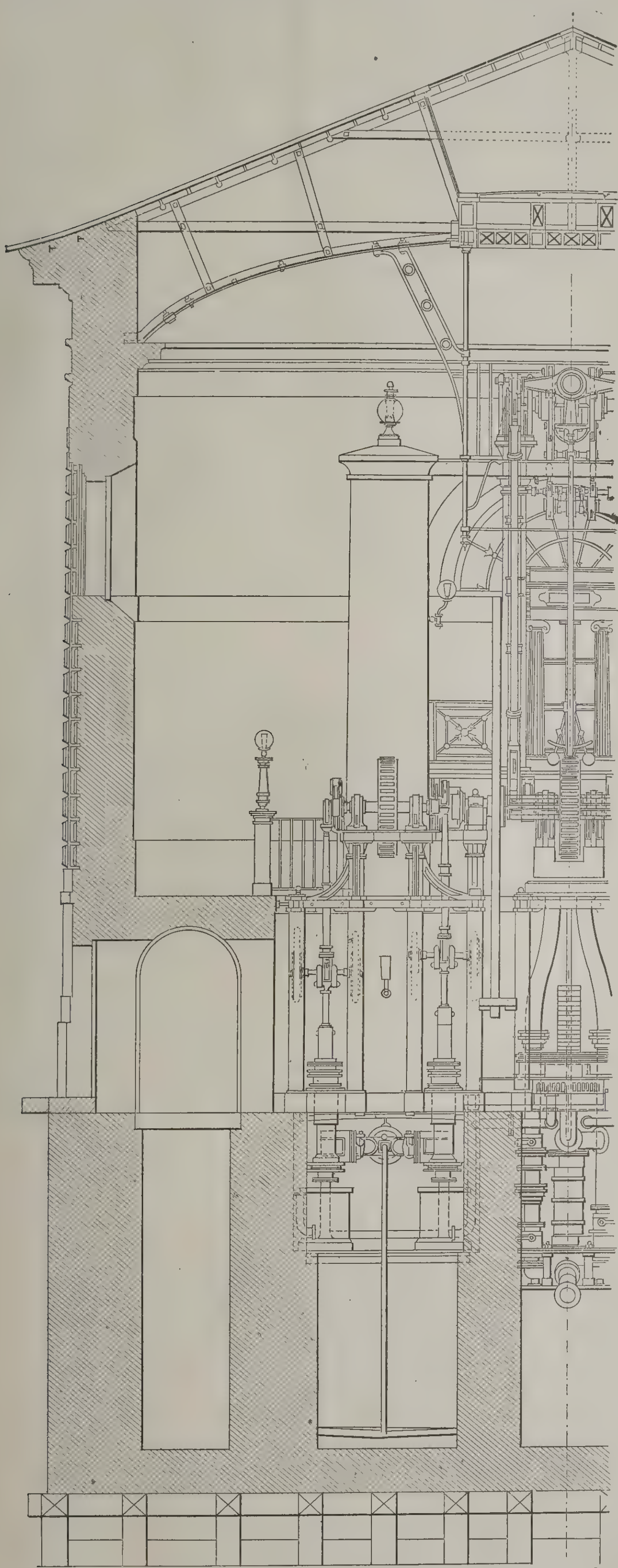


Fig. 6. Details of Building and Arrangement of Pump Cylinders.

tion had he asked from the Civil List the funds needed to repair the dam, which was considered useless after the steam engine had been completed.

In this interesting report, M. Usquin called attention to the irregularity of the service of the water pools as well as the unhealthfulness of the water itself. He also emphasized the cost of water raised by the steam engine, and ended his work by demanding "the construction of a new hydraulic machine at Marly, according to present practice."

"This construction should be made with due attention to the desired solidity. Wheels should no longer be made of wood, but of iron, and they should not be carried upon wooden beams, but upon stone piers."

According to this report, dated in 1837, it appears that the work of this engine was even then unsatisfactory, and an estimate calling for an expenditure of 3,000,000 francs ($600,-000) was called for to replace it with other works, that were really not completed until more than twenty years afterward, when the engine was shut down and taken out of service.

G. L. F.

HIGH-LIFT TURBINE PUMPS—THEIR DESIGN AND EFFICIENCY.

Prof. J. R. Durley, *in Engineering Magazine*, July, 1906.

Under the above heading the author presents a valuable paper; the subject is treated in a clear and simple manner, the general principles and design of high-pressure centrifugal, or turbine pumps being fully exemplified by the aid of line drawings, while the appearance of the pumps of several of the best known makers is shown in numerous halftone illustrations. The paper is lengthy, but in the following abstract we have endeavored to give all the important features:

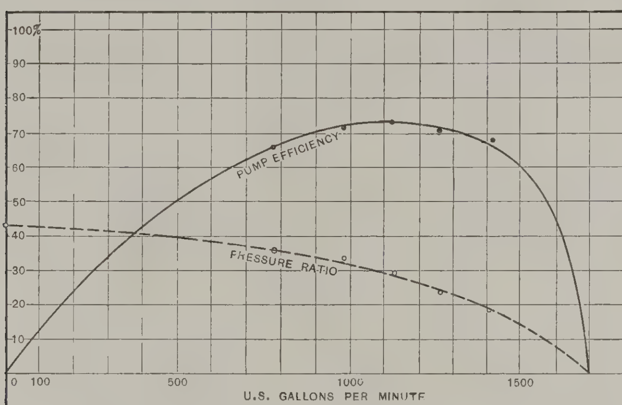
The centrifugal pump, in which there is only one moving part, the impeller, is the simplest form of pump from a mechanical point of view. Unfortunately, the commercial use of such pumps has hitherto only been possible under certain conditions, and for low heads, but a machine of the same simple construction, having only one moving part is now available for high heads in the shape of the high-lift turbine pump, which is practically a reversed inward flow turbine, but differing from the latter in the shape and curvature of the wheel vanes and guide blades.

The ordinary centrifugal pump has a low efficiency when working against high heads, due to the fact that with high speeds the frictional and eddy losses bear a very high proportion to the amount of useful work actually expended in pumping the water. A typical centrifugal pump of ordinary design, showing a maximum efficiency of say 70 per cent at 20 feet lift, will show only about 20 per cent at 80 feet. Efforts to utilize such centrifugal pumps for higher lifts by running two or more in series have not achieved commercial success.

The water streaming from the rim of the impeller of a centrifugal pump possesses kinetic energy, derived from the work expended in rotating the pump. If the vanes of the impeller were radial in an ideal frictionless centrifugal pump, and if the whole of the kinetic energy of the water at the rim of the impeller could be transformed into pressure energy, then the pressure against which such a pump could just deliver, would be calculated by the expression $v^2 \div 32.2$, where v is the linear velocity of the rim of the impeller in feet per second.

If we take the case of water delivered from an ordinary centrifugal pump with a velocity of 10 feet per second in the discharge pipe, under 50 feet head, the total energy possessed by each pound of water delivered is 51.55 foot-pounds, of which 1.55 foot-pounds is kinetic energy and 50 foot-pounds is pressure energy. An ideally perfect pump would attain this result by the expenditure of 51.55 foot-pounds of work per pound of water pumped, and the impeller would have a peripheral velocity of about 41 feet per second. An actual pump, however, working under these conditions, and having an efficiency of perhaps 50 per cent would require the expenditure of twice as much work per pound of water pumped, and the impeller would have to be driven at a considerably higher speed, depending on the design, probably about 60 feet per second. To judge of the performance of a centrifugal pump, under any given conditions, it is necessary to know two things: the efficiency and the "manometric coefficient," which is the ratio of actual pressure in the pump discharge to the pressure which would be attained in an ideally perfect pump with the same peripheral velocity of impeller. Curves of these two quantities, plotted with regard to the amount of

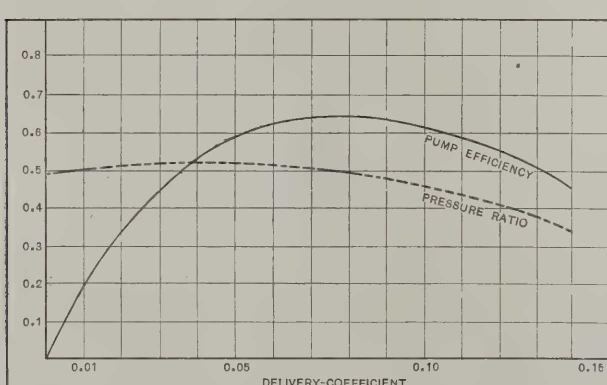
water discharged will give all necessary information as to the performance of a pump at a given speed throughout its whole range, from the point at which the discharge is zero and the pressure large, to the point at which the pressure is zero and the discharge a maximum. The forms of these curves are affected considerably by the shape of the vanes of the impeller, and can be varied by a skillful designer to suit special conditions. Fig. 1 shows the efficiency and pressure curves for an 8-inch low-lift centrifugal pump tested by Messrs. Denton and Kent. The pump was designed for a delivery of 1,200 U. S. gallons per minute against 45 feet head when running at 2,000 revolutions per minute, and it will be seen that while the maximum efficiency of the pump occurs at very



Machinery, N.Y.

Fig. 1. Efficiency and Pressure Curves for Low-lift Centrifugal Pump.

nearly the designed rate of discharge, it falls off rapidly when delivering larger quantities of water. The curves of Fig. 1 correspond to the forms usually shown by pumps in which the vanes are curved backwards at the tip, and such impellers may be used in cases where a pump has to work with fair efficiency at constant speed while the head is varied over a considerable range. It is possible by modifying the shape of the vanes, making them nearly radial, to obtain a pressure-coefficient curve approximately horizontal for a considerable variation of the amount of water pumped; indicating that with such an impeller, when the demand for water is changed, the pressure will remain nearly constant while the pump runs at constant speed. Such a design is suitable for a pump supplying a boiler-feed system. By still further changes in the design of the vanes, we are even able to obtain a pump in which the head increases as the delivery is increased.

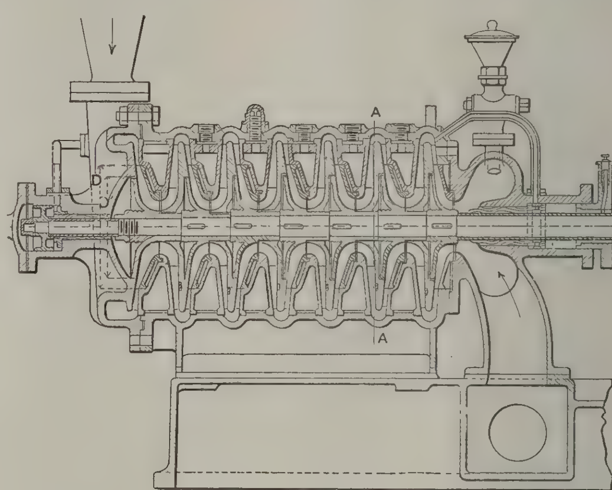


Machinery, N.Y.

Fig. 2. Efficiency and Pressure Curve for a Four-stage Turbine Pump.

Such curves as those just given may be called the characteristic curves of the pump, although they apply only to the particular pump and speed for which they are drawn. M. Rateau has shown that instead of measuring the quantity of water along the base line of such curves, a quantity he calls the "delivery coefficient" may be used with advantage. This coefficient is numerically equal to the amount of water discharged, divided by the peripheral velocity of the impeller, and by the square of the radius of the latter. A given characteristic curve plotted in this way becomes applicable to pumps of all sizes of the same design, the correct speed being used for each size. This result follows because the quantity delivered by an ideal centrifugal pump varies as the peripheral velocity of the impeller, and as the square of the linear dimensions of the pump. A characteristic curve of this kind, for a four-stage pump is given in Fig. 2. The improvement which differentiates the high-lift centrifugal pump from the ordinary low-lift centrifugal pump, consists in the addition, outside of the impeller, of a "diffusion ring" containing stationary guide blades (Fig. 4). By means of these blades the water leaving the impeller is smoothly conveyed to the annular discharge chamber, and its velocity head is more effectually converted into pressure head. The high peripheral velocities of impeller necessary for high heads can then be employed without a corresponding diminution of efficiency. The practical result obtained by this method of construction is that pumps having a simple impeller can deal with heads exceeding 100 feet with good economy; the efficiency possible depends on the design of the pump, and especially on the relation between the diameter of impeller, the required number of revolutions, and the amount of water to be pumped. By placing turbine pumps in series a multiple-stage pump is obtained, and it is possible to pump against greater heads; under these conditions a pump efficiency of over 70 per cent is frequently attained. The greatest head dealt with commercially up to the present time appears to be about 1,500 feet, but for such a lift the usual practice would be to use two or more multiple-stage pumps in series. The usual head for a single multiple-stage pump is from 300 to 600 feet.

It must not be supposed that such results as those just stated have been attained without much trouble, and overcoming many practical difficulties. One of the first difficulties to make itself felt was end thrust on the pump shaft. In a single-stage turbine pump the water at entrance to the impeller is flowing parallel to the axis of the shaft, and in being deflected so as to move in a radial direction it exerts a considerable thrust along the shaft. The simplest way of avoiding this thrust is by using an impeller that takes water on both sides, but when a number of impellers are placed in series on the same shaft, as in Fig. 3, this construction cannot be used. In Fig. 3 the impellers take water on one side only and the end thrust is taken care of by suitably proportioning the areas of the two sides of each impeller, and by the use of a rotating balance piston, one side of which is exposed to the pressure in the discharge pipe. It will be noticed that in this pump the impellers have a larger diameter on the inlet side than on the side nearest to the pump discharge; these areas are chosen so that the difference of the total pressures on the two sides of each impeller balances its own end thrust as nearly as possible.



Machinery, N.Y.

Fig. 3. Seven-stage Pump, Piston Balanced.

One of the first multiple-stage pumps adopted an arrangement in which the impellers were placed in pairs back to back (Fig. 5). In the Buffalo pump, Fig. 6, we have a somewhat similar design, in which the spaces between the outer faces of the impellers and the adjoining casings are used as pressure chambers. Packing rings are fitted, so as to prevent leakage from the delivery to the suction side, and the areas of the two pressure chambers of each impeller are arranged

so as to make the total difference in axial pressure approximately equal to the thrust due to the difference of inlet opening in the two impellers of the pair. In this way each pair of impellers is balanced perfectly.

Another method which can be employed to balance a single-suction impeller involves the use of radial vanes formed on the outside surfaces of the impeller, and therefore rotating the water in the pressure chambers. By proportioning correctly the length and clearance of these vanes, the pressures existing in the various pressure chambers while the pump is running can be brought to the amounts required for balance. These so-called "triple-vanes" increase slightly the power required for driving the impeller, but it is questionable whether the power wasted in the thrust bearing of an imperfectly balanced pump would not be greater than any loss due to the triple vanes.

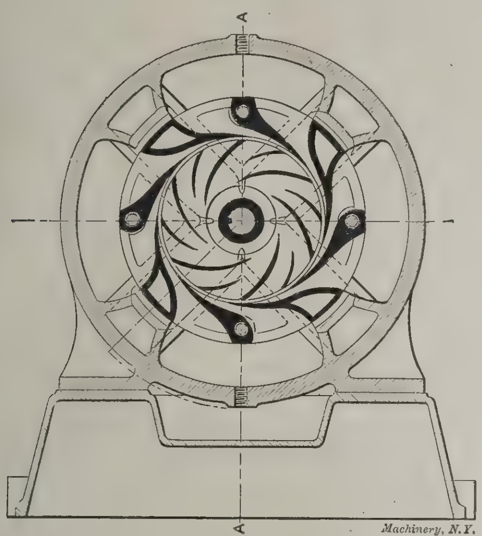


Fig. 4. Characteristic Arrangement of Blades in a Turbine Pump.

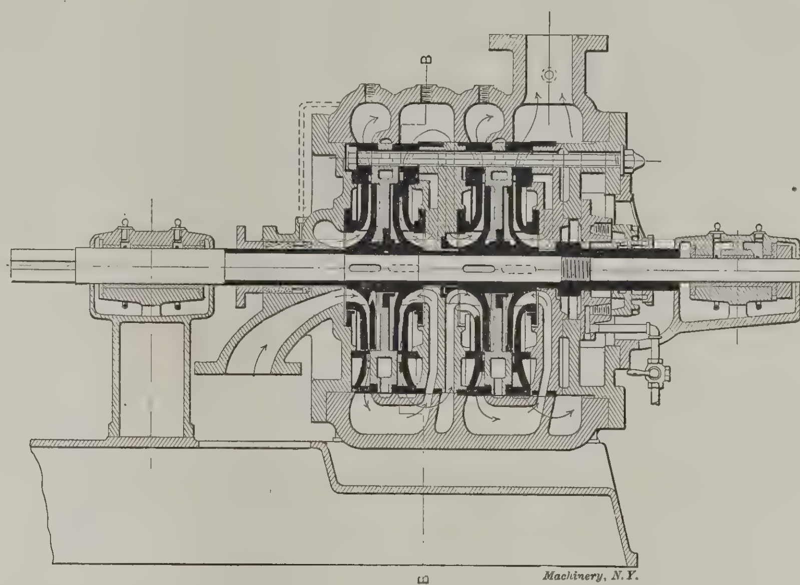


Fig. 6. Longitudinal Section of Pump shown in Fig. 4.

The construction of the main bearings and stuffing boxes in a high-lift turbine pump has to be carefully considered. It is good practice to arrange the design so that the bearings and stuffing boxes are quite separate; in this way the weight of the shaft and its impellers is carried by easily accessible bearings, no grit from the water can get to the journals, and the stuffing boxes are able to perform their own duty without taking any load. The tightness of the stuffing box on the suction side of the pump is specially important, and this box is generally provided with a water supply, so that any leakage into the pump will be of water and not air. Fig. 6 shows an arrangement of double stuffing box for the suction side fitted with such a water-logging attachment. A comparatively small air leak on the suction side will suffice to prevent the pump from working at all. The pump may be constructed so that water leaking from the last pressure chamber is used to cool the bearings.

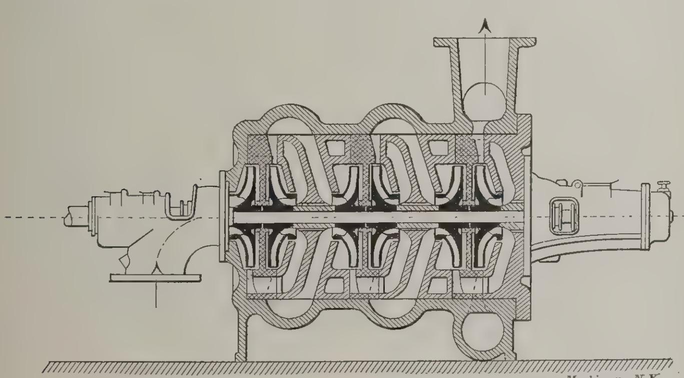


Fig. 5. A Balanced Multi-stage Pump.

Other points requiring attention in design are, the protection of the exposed portions of the shaft from corrosion; the prevention of leakage from one stage to the next, by fitting brass packing rings; and the arrangement of the impellers and division plates so as to admit of easy assembly and removal without interfering with permanent pipe joints or connections. The form of the guide passages in the diffusion ring, and the shape of the ports or passages leading from one stage to the suction of the next, have considerable effect on the efficiency of the pump.

The results attained by the modern high-lift centrifugal pump may be stated generally as follows; an efficiency in most cases of from 70 per cent to 75 per cent can be obtained, and under suitable conditions this may even reach 80 per cent on trial. The pumps can be so proportioned as to give a fairly constant efficiency over a considerable range of discharge. When running light, the power absorbed is generally from 25 to 40 per cent (see Fig. 17) of that at the rated output of the pump.

In good practice the head to be overcome by each stage is from 100 to 200 feet. When the head is more than 200 feet it is difficult to obtain high efficiency, owing to the high velocity of the water. The maximum speed of the impeller is limited by the rapidity with which water can flow into the suction. The greatest number of stages now used is eight, but there seems to be no reason why the number could not be increased.

It is probable that further progress will soon enable efficiencies corresponding with the best water turbines to be obtained. Tests of turbine pumps after some years' work have shown that when properly constructed there is little falling off of efficiency on account of wear and corrosion. Turbine pumps can maintain their original efficiency much better than is usual with large piston pumps.

Turbine pumps are lighter and smaller than reciprocating pumps. A reciprocating pump driven by a 300-horsepower motor and occupying a floor space of 50 x 25 feet was replaced by a turbine pump driven by a 500-horsepower motor that occupied a floor space of 31 feet 6 inches by 8 feet 6 inches; and the weight of the latter is about one-half that of the former. The reciprocating pump delivered 4,500,000 gallons per twenty-four hours, and the turbine pump 6,500,000, the head being 300 feet.

High-lift turbine pumps of the largest size are now being employed to supply water for cities and towns. They are also used extensively in mines. In the latter service they are not only employed as permanently located drainage pumps, placed conveniently in chambers excavated near the bottom of the shaft, but also as sinking pumps, in which case they are suspended in the shaft in suitable frames; and, owing to their small size, they leave ample room for the passage of the

cages or tubs of the hoisting apparatus, even when of considerable power.

High-lift pumps are finding a wide application for purposes of fire protection, both in factories and cities. A fire protection system now being installed in Toronto comprises two two-stage Worthington pumps, each directly connected with a steam turbine of 1,000 horsepower capacity.

In Europe high-lift pumps driven by electric motors have been used as portable fire engines with considerable success. For elevator service these pumps give good results if arranged to be controlled electrically or mechanically, so as to vary the discharge automatically in conformity with the demands of the elevator.

A number of successful pumping installations have been carried out in which a high-lift pump has been driven directly by a water turbine. Such a turbo-pump, as built for mine service in Central America, consists of a four-stage Rateau pump having impellers 9½ inches in diameter, and driven at 2,200 revolutions per minute by a reaction turbine placed within the same casing. The 120-horsepower turbine, taking its water under a head of 520 feet, has a single wheel 11¾

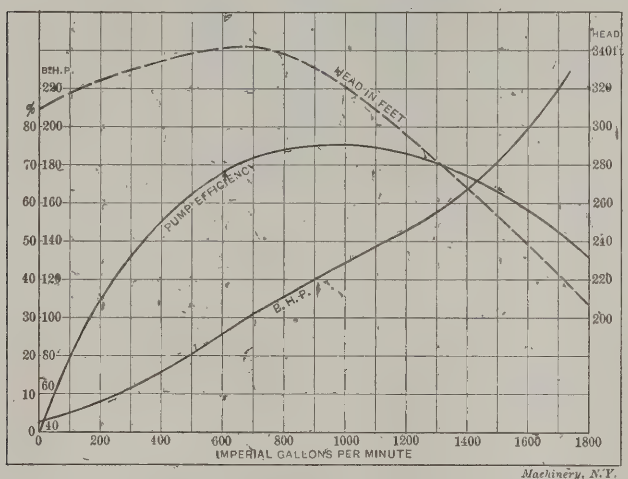


Fig. 7. Characteristic Curves from a Turbine Pump Test.

inches in diameter, and delivers the water it has used into the discharge pipe of the pump; the pump works under a head of 390 feet and delivers 400 imperial gallons per minute. The combined efficiency of the pump and turbine is 48 per cent.

High-lift centrifugal pumps directly connected to steam turbines are used in many cases and have shown good results as far as steam consumption is concerned. Under favorable conditions a consumption of 22.6 pounds of saturated steam per pump horsepower per hour has been shown on a seven-stage pump delivering 900 imperial gallons per minute under 1,180-foot head, and taking about 320 horsepower.

Although high-lift centrifugal pumps have been on the market for only about nine years in Europe, and four years in America, their use has become widely extended. Such pumps are now commercially available for almost any service, so long as the amount of water to be dealt with is not too small in comparison with the head at which it is to be delivered.

W. B., Jr.

* * *

The Anglegraph is the name of a device for draftsmen manufactured by the Cassady-Fairbanks Mfg. Co., 6106 La Salle St., Chicago, Ill. It consists of a triangular piece of sheet metal, nicely finished and nickel plated, in which is drilled a series of holes, so spaced that a variety of geometrical figures can be constructed by its aid. By placing a tack or pin through one of the holes as a pivot, circles of different diameters can be drawn by means of a lead pencil, the point of which is inserted in any one of the holes desired. Certain of the holes are numbered and by the aid of directions given they may be used in connection with a pencil point to divide a circle into any number of equal parts up to 16 and by the use of the several gages of the instrument, in connection with the numbered holes, geometrical figures of complicated construction can be drawn.

DYNAMO AND MOTOR TROUBLES.

WITH CHART WHICH APPEARS IN THE SUPPLEMENT.

F. W. S.

A number of small volumes have been written on the care of electrical machinery, particularly dynamos and motors. Most of these books are very useful in assisting the operator in the proper maintenance of the apparatus and the discovery of the causes of faults and breaks which are constantly liable to occur. Almost any given symptom of distress in a dynamo or motor, however, may be due to a number of different causes. This fact, together with the lack of method in the arrangement for some of the books dealing with the subject, often handicaps the beginner in locating the particular fault to which any given trouble is due.

Roughly speaking the various diseases to which dynamos and motors are subject may be placed in six general classes. First, sparking of the brushes; second, heating of the parts; third, noises; fourth, variations in speed; fifth, miscellaneous derangements peculiar to motors as distinguished from dynamos; sixth, miscellaneous derangements peculiar to dynamos and generators as distinguished from motors. It is again possible to divide each of these major symptomatic indications into minor ones. The sparking of the brushes, for instance, may be due, first, to faults of the brushes; second, to faults of the commutator; third, to excessive currents in the armature; fourth, to faults in the armature. Each of these divisions may be again subdivided and an appropriate individual remedy indicated.

To make this clearer I have prepared a chart showing the arrangement I have in mind. This chart appears in the Supplement and to illustrate its use we will suppose, for instance, that the armature of a motor becomes dangerously hot after running for a time: The chart is consulted and under the heading of "heating of parts" the sub-head "armature" is found. There are seven different causes given here for heating of the armature. It may be due to overload of the motor, to a short circuit due to carbon dust, etc., on the commutator bars, or it may be caused by a broken circuit, a cross connection, moisture in the coils, eddy-currents in the core, or heat conveyed from a hot box or journals through the shaft. Each of these seven causes may be investigated in turn. For instance, it may be found that the armature coil is warmer than the winding which surrounds it. If this is the case, the trouble is due to eddy-currents in the core, or to heat conducted through the shaft from a hot box. If the latter the shaft will of course be hotter than the armature, and the bearings still hotter than the shaft. If the trouble is due to eddy-currents the armature will be found to be made of solid metal, or to be not sufficiently laminated. In either case the trouble is readily discovered.

There are two advantages in using a chart of this kind. In the case of trouble with a motor or dynamo, a text book is generally too voluminous to be easily used and, quite likely, is not well enough arranged to permit a quick diagnosis. Then again, after a person has carefully read over such a work several times, he will still find the chart very acceptable, as a guide which will show him where to look and what to do—something that can be glanced over quickly and can be readily found, which will outline the proper course to pursue. The trained mind will then quickly recall from the book the details of the proper method of procedure.

* * *

About 40,000 tons of tin are consumed annually in the United States, about half of which is used in the manufacture of tin plates and solder. It is interesting to note that improvements in the manufacture of cans for fruit, vegetables, meats, etc., has decreased nearly one-half the amount of solder required per can, thus illustrating how machinery may in some cases work out an economy of the use of materials as well as a saving of labor. The annual consumption of tin is about 90,000 tons for the whole world and the scarcity of the product is constantly forcing the price upward. A tin mine would be one of the most profitable holdings that a man could own, the price being about 38 cents a pound.

LEATHER MEASURING MACHINE.

H. A. DUDGEON.

The following description of what is really an area measuring machine may be of interest to many of the readers of this journal as it embraces several novel mechanical ideas in its construction, the machine being designed to overcome the objections met with in all previously designed machines for a similar purpose.

It is first perhaps necessary to explain that leather from which the uppers of boots and shoes are cut is sold by superficial measure, or so much per square foot and owing to the irregularity of the outline of the skins themselves, which is something like Fig. 1, it is very difficult if not impossible to obtain an exact measurement and so the near approach to this has to suffice; for whilst being very close to the actual measurement the results obtained are more or less only an approximation and, whilst the machine about to be described is no exception to the general run of machines in that respect, it perhaps approaches being exact more nearly than the others.

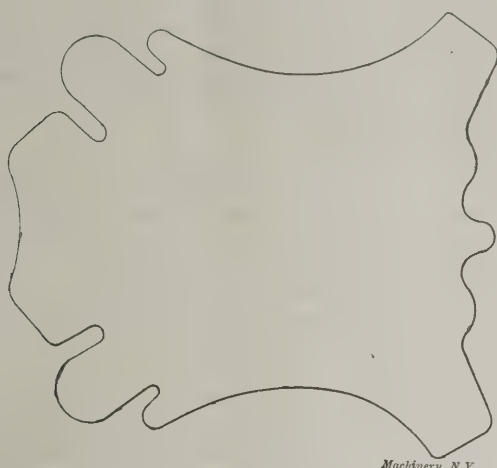


Fig. 1. Sketch showing Typical Outline of Hide.

To put it in simple language the underlying principle of the machine is this: If a wheel of known circumference is traveled along a surface it is an easy matter, by counting its revolutions to calculate the length of surface passed over. If such a wheel were to account for a surface between lines parallel to the motion of the wheel and of known width, and the ends of the surface were straight and square with the sides then the length multiplied by the width gives the area. Now if the skins to be measured were of such a shape the problem would be much easier, in fact would hardly need a machine at all but such, however, is not the case, and as in an engine indicator diagram the surface must be divided into imaginary parallel strips and the mean length or height of each strip measured by providing a measuring wheel for each strip, the results being added together for a final result. Now, if, instead of passing the measuring wheels over the surface the surface is made to pass under the wheels the result is the same, and in the machine this is done, the following description showing how it is carried out in practice and the means adopted for recording the revolutions of the measuring wheels and adding them together.

Referring to Figs. 2 and 3, *A A* are the measuring wheels placed equidistant apart and carried by the arms *B B*, being placed directly above the feed-roller, *C*, which is belt driven. On one side of each wheel is a small boss, and attached to this and wound once around the boss is a fine cord, *D*, the other end of the cord being attached to a movable weight, *E*, there being as many cords and weights as there are wheels. These weights are carried on inclined arms, *F*, secured to a shaft, *G*, the shaft being carried on centers, a ball race being formed in the end of the shaft, the balls resting on the centers, thereby reducing the friction to a minimum. To one end of the shaft *G* is secured a lever, *H*, the outer end of the lever being supported by the coil spring, *J*. In the normal position the weights, *E*, are nearly at the botttom of the inclined arms, and so near the center of the shaft, in that position exerting a certain pressure tending to revolve the shaft *G* about its axis; this is resisted by means of the lever *H* and spring *J*. If one or more of the weights are moved up the inclined arms by any means a greater turning tendency is imparted to the shaft and a greater deflection of the spring takes place.

This then is what happens in the machine: The leather is placed on the table *K* and fed between the feed roller *C* and the measuring wheels, *A*, some of the latter being caused to revolve, the number in action being governed by the width from left to right of the skin, each revolving just so much, according to the length of the surface passed under them. And this, by means of the cords draws the weights up the inclined arms a certain definite distance, their combined action thereby deflecting the spring *J* through the shaft *G* and lever *H* a predetermined amount proportional to the position of the weights. It is an easy matter to record the movement of the shaft. This is done by means of the rod *L* attached to the lever *H*. At the top of the rod is a rack which meshes with suitable gearing actuating the hand *S*. This hand moves in front of the dial *M* placed in a convenient position on the

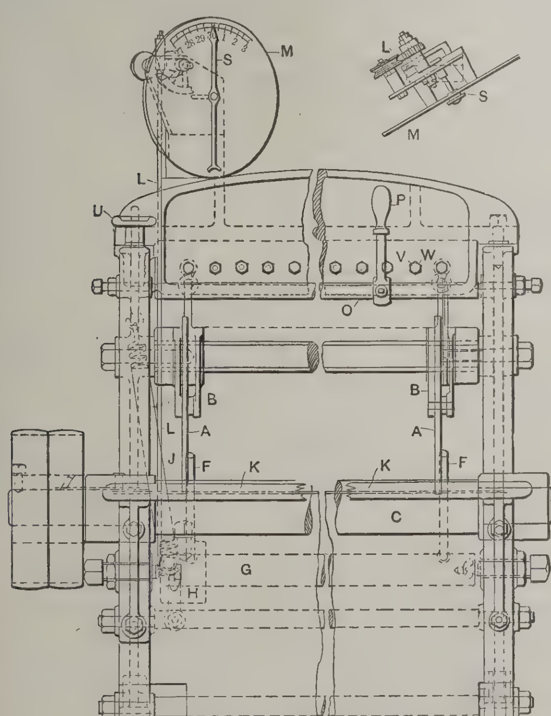


Fig. 2. Front View of Leather Measuring Machine.

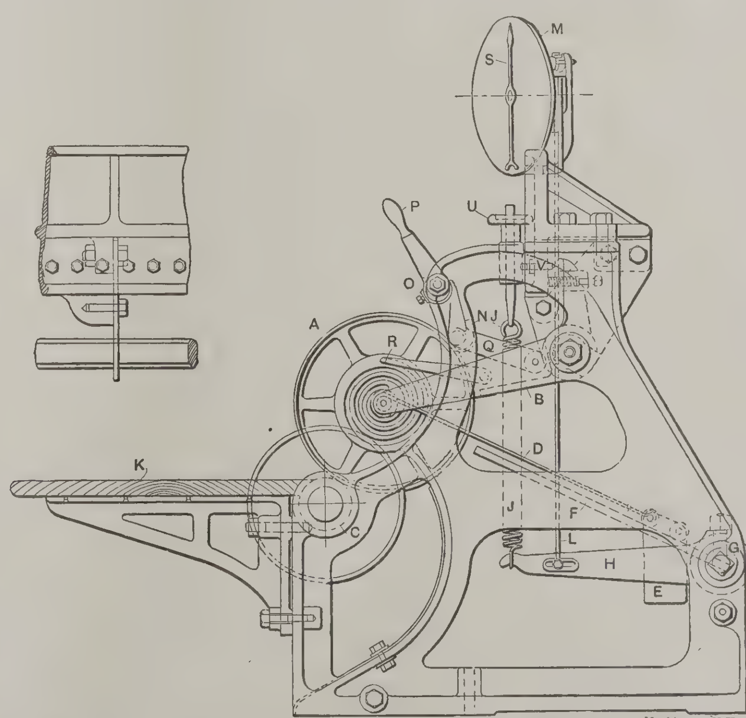


Fig. 3. Side View, showing Measuring Wheels and Weighing Mechanism.

machine, the graduations giving a direct reading in square feet.

A brake N is provided for each measuring wheel to retain it in position until the reading has been taken, the brakes all being released simultaneously by means of the eccentric shaft O and handle P, the shaft in its normal position being just clear of the extension on the brake lever Q when the brake is resting on the wheel. By turning the eccentric shaft, all the brakes are lifted from the wheels together, and the weights travel down the inclines into their normal position. To insure the weights stopping in their proper positions at the bottom of the inclined arms a scroll is formed on the face of each measuring wheel in which a small projection on the end of the lever R lies. As the measuring wheel revolves forward this projection follows the path of the scroll, and when the wheel revolves in the reverse direction the end of the scroll strikes the projection on the lever.

An interesting feature in the machine is the method adopted to prevent registering *surface* when only *thickness* has passed through. The measuring of this can be best shown by means of a diagram. In Fig. 4 let A represent the measuring wheel, C the feed roller, K the table, and N the brake. Now if a solid represented as an end view by the triangle T be passed through the machine it is evident that the measuring wheel

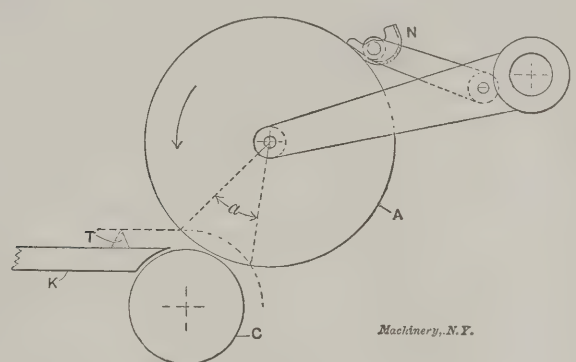


Fig. 4. Compensating Device for Thickness of Hide.

A will rotate a certain amount equal to the angle a, although obviously the line representing the apex of the triangle has no area.

Similarly any substance passed through the machine will move the measuring wheel through a similar angle proportional to the thickness of the substance *in addition to the surface of the substance* and unless provision is made this angle will be added to the reading, giving an incorrect result which, considering that on an average 30 wheels are in action on each skin measured, is a serious matter. To overcome this the brake was made of such a form that for part of a revolution of the measuring wheel the brake turns with it, the amount being calculated from the angle through which the wheel turns for an average thickness of leather. Any further movement of the measuring wheel in a forward direction shown by the arrow causes the brake to slip but as soon as each wheel ceases measuring the part of the skin passing under it, the weight on the inclined arm revolves the wheel in the reverse direction just the predetermined amount, this reverse movement of the weights being therefore deducted automatically from the reading.

The nut U is for adjusting the indicator to zero when first setting up the machine and the screws V are used for setting the measuring wheels A just clear of the feed roller, being locked by means of the nuts W.

* * *

A motor-driven rail mill is now in operation at the Edgar Thompson plant of the Carnegie Steel Co. at Bessemer, Pa. It is equipped with two 1,500-horsepower, 30-pole, 220-volt, direct-current motors overcompounded 15 per cent, which operate at from 100 to 125 R. P. M. Each motor carries a 125,000-pound cast-steel segmental flywheel which frees the motor from the extreme shocks of rolling. The power delivered by each motor ranges from 950 to 1,450 horsepower in rolling rails with occasional jumps to 1,700 horsepower, while the friction load on the mill running light is about 500 horsepower.—*Engineering Record.*

NEW DUTY RECORD ESTABLISHED FOR THE PUMPING ENGINE.

Tests which were made upon a twenty-million-gallon Allis-Chalmers triple expansion pumping engine at the Bissel's Point Station of the St. Louis Water Works in the latter part of February, 1906, determined the production of an indicated horsepower per hour on an average consumption of 10.59 pounds of dry saturated steam. The average heat supply was at the rate of 201.39 B. T. U. per minute horse power, giving a thermal efficiency of 21.06 per cent. The mechanical efficiency was 97.4 per cent; the duty per 1,000 pounds of steam 181,068,605 foot pounds, and per million British thermal units 158,581,000 foot pounds. The guaranteed duty was 135,000,000 with a bonus of one thousand dollars per million foot pounds, so that the engine earned its builders $46,068.61 above the contract price.

The engine tested is the last of a series of three installed at the above station, and is of the vertical triple-expansion, self-contained type, with single-acting outside-packed plungers located directly under each cylinder. The lower bed-plates rest on solid rock foundations; the main pillow block bed plates are supported upon cast iron frames resting on the lower bed plates and the cylinders are supported by frame of the "A" pattern.

The cylinders are 34, 62 and 94 by 6 feet stroke with water plungers 33⅞ inches in diameter. Before the official test the plungers were carefully calibrated by micrometer calipers checked by steel tape measurement of circumferences. The strokes of all plungers were also carefully measured. The pump valves were inspected and found to be tight under full pressure.

The specifications and contract required that, "In order to determine the amount of steam used by the engine, the water will be weighed twice; that is, the feed water going into the boiler and the condensed steam coming out of the engine." Accordingly, the condensation from the condenser, jackets, receivers and drips from stuffing boxes was weighed as received from the engine and delivered in the boiler room, and was found to check by 0.12 of one per cent. This being a reasonable check the water as weighed in the engine room was taken as the steam used.

The gallons of water pumped in twenty-four hours was 20,070,590 against a head of 100.021 pounds at the discharge pipe, the contract requiring 100 pounds pressure. The head in the discharge main was read by means of a mercury column and the suction head by a float gage. The plunger leakage was weighed and found to be 16.77 gallons per hour. Steam of 140 pounds pressure at the throttle was furnished containing 0.13 per cent moisture.

RESULTS OF DUTY TEST.

Duration of test	24 hours
Diameter of cylinders	34, 62 and 94 inches
Stroke of engine	72 inches
Diameter of plungers	33⅞ inches
Average steam pressure at engine	140.24 pounds
Average first receiver pressure	26.36 pounds
Average second receiver pressure	2.77 pounds
Average vacuum pressure by cards	13.21 pounds
Average barometer pressure	14.46 pounds
Average net head pumped against	238.2323 feet
Average revolutions per minute	16.539
Piston speed per minute	198.44 feet
Total water pumped	20,070,690 gallons
Total water received from engine	220,129 pounds
Average moisture in steam	0.13 per cent
Indicated horse power	865.22 horse power
Delivered horse power	842.69 horse power
Per cent friction	2.60 per cent
Average moist steam per I. H. P. per hour	10.60 pounds
Average dry steam per I. H. P. per hour	10.59 pounds
Average B. T. U. per I. H. P. per minute	201.39 B. T. U.
Mechanical efficiency	97.4 per cent
Duty per 1,000 pounds of steam	181,068,605 foot pounds
Duty per 1,000,000 B. T. U	158,851,000 foot pounds
Thermal efficiency	21.06 per cent

* * *

The yearly index for MACHINERY is now ready and will be sent to all subscribers upon request.

THE COST OF RUNNING MACHINERY.

D. C. EGGLESTON.

The cost of running machinery is such an important subject in factory economy that a discussion of the items making up the "Machine Expense" may be of interest to readers of MACHINERY. Cost accountants have used the term "Machine Expense" to include the total charges incurred in running the machine equipment of a factory. It costs money to maintain a machine, repair it, pay taxes on it, rent floor space for it and so on, as well as it does an operator to live, and oftentimes the machine is the more expensive of the two. The "Machine Expense" is always more difficult to figure than the labor expense and more economies can usually be made by a study of it. The importance of studying this subject will be realized when it is known that the "Machine Expense" in one factory was 70 per cent of the cost of labor on jobs passing through all departments. The more expensive and intricate the machine is the more the "Machine Expense" will be, but this does not vary with labor. One operator will oftentimes tend a half-dozen automatic screw machines, and it is easily seen that the "Machine Expense" is greater in proportion to the cost of labor than if he were tending only one drill press. This variation in the cost of maintaining the machine equipment of a factory with the labor is one reason why the percentage plan of figuring costs leads to erroneous results wherever the machines in a factory are of different types.

As soon as a machine is installed certain expenses called fixed charges begin. A machine which has been used cannot be sold for as much as it cost. Not only has the wear and tear on it made it less valuable, but perhaps the manufacturer can supply a newer and more efficient type, which makes the old machine less valuable. In short, longevity and obsolesence must be considered in fixing the rate for depreciation. The engineer must use his best judgment in estimating the probable life of a machine and then enough money must be set aside each year from the profits if put at compound interest to redeem the machine when the time comes for replacing it. As high as 15 per cent of the face value is oftentimes written off, but it varies so much that the best judgment must be exercised in all cases.

Insurance must be taken after deducting the reserve for depreciation. Taxes are also an element of expense and belong to the fixed charges account. In a Pratt & Whitney No. 1½ hand screw machine costing $731.25 the fixed charges amounted to $66.81 a year.

The cost for power is an important item in most machinery and the exact amount used should be found by metering it. In estimating the cost of power all fuel, oil, wages of firemen and sundry expenses should be included. In the machine mentioned the yearly charges for power were $142.90.

The machine occupies floor space in the building and should bear its share of the expense incurred in maintaining the building in an efficient state for conducting the work of the factory. The best way is to charge all repairs, changes, fixed charges and expenses for cleaning to rent expense and then prorate this according to the floor space occupied, making the machinery bear its proper part. In the machine previously used for illustration the rent expense amounted to $41.90 a year.

All administration expense, including salaries of superintendent, foremen, clerks, traveling, entertainment, stationary, and so on should be summarized and prorated according to the number of productive employees. If one employee works at a hand screw machine the administration expense which must be included in the cost of running that machine is the amount allotted to one employee. If two employees work at a multiple drill press the administration expense is double that for one employee, and so on.

All repairs, changes and expense incurred in behalf of the tool equipment, salaries of tool inspectors, tool clerks, and fixed charges on small tools should be distributed among the different machines by estimate and analysis. It will be found that tool expense is the largest item of "Machine Expense" and a careful study of the items making it up will suggest valuable economies.

Sundry expense is designed to cover all items not chargeable to other branches of "Machine Expense" such as oils, chemicals, water other than for boilers, defective work and stationary. Although this expense is only about one-fifth as much as tools expense it ought to be divided among the various machines by estimate so that each machine will bear its proper share.

For purposes of cost accounting it is necessary to include the cost of running non-productive machinery in the cost of productive machinery. Thus the cost of running a filing machine which is used for filing the saws for eight saw tables would be assessed equally against the saw tables.

The sum of the fixed charges, power, rent, tool and sundry expense, together with the non-productive machinery assessed against a machine, is the total cost of running it. If the total cost for running it one year be divided by the yearly number of working hours the hourly machine rate can be found. Then this "Machine expense" can be charged on the job ticket the same as the operator's time. If the cost of material, including material expense, is added to labor and "Machine Expense," we have the total cost to make an article. If the machines are grouped together in classes, it is not a very difficult task to estimate the rates, and the accuracy of figuring costs where this system is employed justifies the trouble incurred in accurately finding the cost of running machinery.

* * *

CHINESE RAILROADS AND CHINESE GRAVES.

Speaking of the difficulties experienced by railway builders in China in pacifying the descendants of the numberless dead, disturbed by the building of the road, Mr. Ashmead, head engineer of the Canton-Hankow railway, in the course of an interesting contribution to the *Engineering News* states that, while the prices of graves are variable, the average is 4 taels (about $2.80) per coffin. There being no grave yards in China, as with us, and the location of each separate coffin having been chosen previously by geomancer, according to immemorial Chinese custom, it requires much tact on the part of the native and foreign officials of the road to accomplish the removal of coffins from the right of way, as graves cover much of the ground, being thickly scattered over the lowland, as well as on the hills and mountains. This observation as to the vast number of graves met with in China calls to mind a remark made by a gentleman who had lived for some years in that country to the effect that the Chinaman has carried out to its logical extreme the idea of the reduction of waste. Forced as he is to live in a country so thickly populated that its inhabitants are barely able to find food for themselves, great effort is made to protect the constantly worked soil from loss of productiveness. Not only is every particle of garbage and household waste from each village collected and returned to the adjacent land to refertilize it for next year's crops, but the Chinaman himself, when his end comes, feels that he also must return to the soil from which he has drawn his sustenance. His body is therefore carried outside his native village and buried just a few inches below the surface, where the fertilizing properties which he has drawn from the food during life will be available for the plants growing around him, destined for the future support of his friends and neighbors. How much this idea of returning to the soil everything he has taken from it is accountable for the Chinaman's desire to be buried in his own land, it is hard to say, but his careful economy of phosphates and nitrates is in sharp contrast with the customs of the inhabitants of Europe and America, whose rivers, as Huxley, we believe it was, pointed out many years ago, are constantly carrying to the ocean untold treasures of fertilizing material.

* * *

The danger attending the pouring of melted lead into a cavity without making sure that the hole is perfectly dry is illustrated by an accident befalling a Herkimer, N. Y., man some weeks ago. He poured some hot lead into a hole in the cement floor for the purpose of filling around a pipe and it turned out that there was some water in the hole. The melted lead was thrown out with tremendous force, striking him in the face and badly burning him in several places. Fortunately, eyeglasses saved his sight.

DOWEL MAKING MACHINE.

An interesting woodworking machine was described, in principle, several months ago in *Wood Craft*, being a dowel making machine built by W. C. Farnum, Arlington, Vt. The machine makes the dowels from the log, the logs being first cut up into bolts of the length of the finished dowels. These bolts are then mounted on the machine and the dowels sawed out round and to finish size by means of a tubular saw. During this latter operation the dowels are cut out of the bolt from positions corresponding to those of the cells in a honeycomb; that is, in rows which cut each other at an angle of sixty degrees. It is asserted that by this method a saving of about one-third is obtained over the old process, both in material and time.

Fig. 1 is a plan view showing the operation of the tubular saw and shaper head cutting cylinders out of the block of wood, or, in other words, milling dowels out of bolts. Fig. 2 is a perspective view of the shaper head. Fig. 3 is a perspective view of the tubular saw and a portion of its spindle.

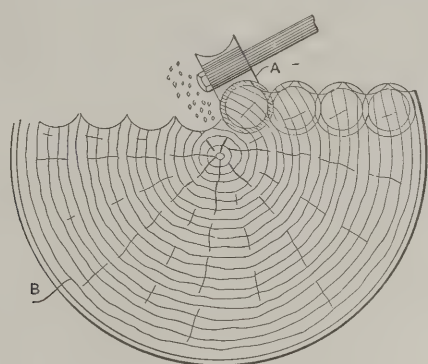


Fig. 1

Fig. 2

Fig. 3

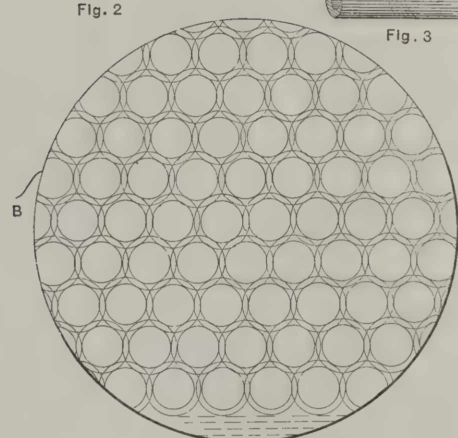


Fig. 4

A Dowel-making Machine.

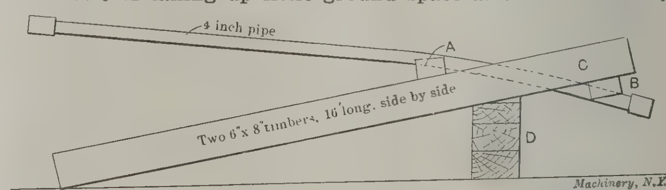
Fig. 4 is a diagram illustrating the arrangement of the dowels in the wooden bolt, or the cylinders in the wooden block. The logs are mounted on a saw carriage and sawed into sections of the length of the finished dowels. The dowels then cut by the tubular saw are a finished commercial product but, usually, are intended as blanks for the making of spools, clothes pins, handles, etc. As shown in the perspective view, Fig. 3, the edges of the throats of the saw teeth back of the cutting faces are beveled or flared outwardly. The purpose of this arrangement is to cause the sawdust to be thrown outward by centrifugal force when the saw is cutting instead of allowing them to remain in the throats and clog them.

The forming cutter, Fig. 2, supplements the work of the tubular saw as may be seen in Fig. 1 at *A*. Here the cutter *A* is shown at work on the bolt of wood, *B*, cutting in advance of the tubular saw and removing the surplus stock for the periphery of the dowel. The section of the saw is seen surrounding the dowel. The cutter *A* routs out and forms nearly one-half of the dowel, thus providing ample room for the escape of sawdust out of the throats of the teeth on the circular saw as well as greatly lessening the amount of work to be done by the saw in cutting out the remainder of the periphery and finishing the dowels, freeing them from the wood. In Fig. 1 the corresponding parts to be cut out by the saw in the succeeding dowels of the same tier are indicated by dotted lines. The dowels and the material cut out by the saw cuts are graphically illustrated for the entire bolt in Fig. 4, together with the small portion at the lower edge of the bolt which is required for gripping in the holder of the machine.

* * *

EMERGENCY RIG FOR BENDING PIPE.

While the streets of New York have a never-ending human interest it not often that the editorial eye sees therein anything of marked mechanical interest that might be classed as a "shop kink," but here is an exception. The job of bending heavy 4-inch pipe in a city street, giving each length two offset bends, is one that most of us would rather not tackle; it would be bad enough to do it in a shop equipped with some suitable appliance. The cut illustrates a street rig that works well, provided enough "dagos" are at hand to give the necessary avoirdupois when the bending operation is done. It has the merit of taking up little ground space and can be readily



Pipe Bending in the Street.

extemporized from standard lumber sizes. Two 6 x 8-inch timbers about 16 feet long are laid side by side about 5 inches apart with one end elevated on blocking, *D*. The pipe is placed between the timbers and the cross pieces, *A* and *B* are placed as shown so as to form a fulcrum and a point of resistance for the short end of the pipe when the weight of the men is applied to the long end. It will be observed that the forces of action and reaction are balanced within the rig itself so there is no tendency for it to shift position. It is not exactly what might be called a labor-saver for six or seven men were employed on the job noticed, but for emergency work, where labor cost is a secondary consideration, it is certainly a meritorious scheme.

* * *

It has not been an uncommon experience for an invention to be made and used without patent protection, and if it should occur that the invention comes into general use the natural inference is that the inventor has lost a large monetary return because of his neglect to protect his idea. While not denying that such may be the case, it is interesting to consider the other side of the question. For example, we might mention the ring-oiling device, first used, we believe, by Prof. John E. Sweet on the crankshaft of his famous "straight-line" engine. The device attracted little attention outside of the engine builders until the advent of the electric generator, when Edison recognized that the ring-oiler was an excellent device for lubricating the journals of this high-speed machine. His use of it was immediately copied by the builders of electrical machines generally, and now it is in common use throughout the world. But the fact that the invention was not patented undoubtedly to a large degree explains its immediate general adoption when it became known. A designer usually feels averse to using any device in a new machine for which royalty will have to be paid if another device, even if not so good but in common use, can be used instead. He is responsible to a large degree for the cost of the machine, and the specification of a patented part which may mean considerable dickering with outside parties before permission can be obtained for its use, is distasteful. If the patented device is something of a concrete nature which can be bought in manufactured form and applied with no further transaction the matter assumes a different form than when it must be manufactured as part of the machine and royalty paid thereon.

LETTERS UPON PRACTICAL SUBJECTS.

MOTOR EQUIPMENT.

I have read with much interest the article on the light machine shop in the June issue. The author gives a table of average horsepower required by various machine tools, which is only applicable to group driving and is by no means of general application. Every case has to be considered on its own merits, and in laying out the equipment of a machine shop it should be the object to have as many machines worked to their full capacity as possible. By this means their earning power is increased, as is also the actual power necessary for driving each tool; in other words aim to make the average power as near as possible to the maximum power required for each machine. This means the adoption of automatic machines wherever possible, and calls for much thought, but will produce results impossible by any other means. It is impossible to set any limit of power required for machines where it will pay to install individual electric drive; although at present it is generally considered more economical to operate machines requiring less than five horse power each by the group drive. Yet such ideas are liable to be changed if we look at a modern printing establishment, where it is universal practice to install individual drives on ¼ horse power presses, and it must be admitted that the equipment of the press room is more advanced than that of the average machine shop.

It should always be remembered that production is the principal consideration, and a greater production is possible where each machine is independently driven.

In the case of the 80 lathes requiring an average of 24 horse power, a good arrangement would have been to use three motors of 10 horse power each, as it is better to run short lengths of shafting, and in case of a break down less time would be lost.

Very important points to be considered are light and cleanliness in a shop, as they have considerable influence upon production. The fewer the belts the lighter and cleaner a shop will be.

Countershafts are quite unnecessary in a manufacturing machine shop, and for group driving an excellent method is used in Woolwich Arsenal, England, described by Colonel Holden in a paper before the Institution of Electrical Engineers, November, 1905. There is one main line shaft having a cone pulley over each machine. These cone pulleys are not carried on the main shaft, but on tubular bearings through which the main shaft passes clear, the bearings being supported on brackets (see illustration No. 6, opp. page 48, Journal of Inst. E. E., Vol. 36). The cone pulley carries the armature of an electromagnetic clutch and the electromagnet is keyed to the shaft. These clutches are quite reliable and very efficient as they do not require more than one-fourth of a watt per horsepower, or 1/3000 part of the power transmitted. Although individual electric drive is apparently too expensive for small machine tools at present, the time will come when the motor will be an integral part of every machine. C. H. Haddrell.

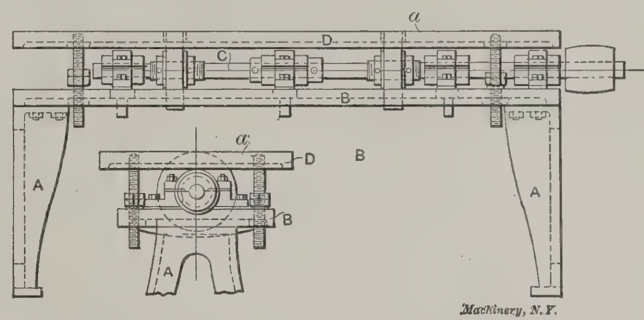
Cincinnati, O.

A SURFACE GRINDING MACHINE.

The accompanying sketches show a surface grinding machine, as used by a large eastern establishment for grinding surfaces that have to be scraped; it can be used for a great variety of work, with a considerable saving of files and time. It is very simple in construction, and not very expensive; one of those handy home-made tools the boys wouldn't do without after its usefulness has once been appreciated.

In almost any shop there is a lathe or other machine, whose time of service has ended, which is fit only for the scrap heap. Its legs can be used for the grinding machine as shown at *A A*. On these legs is fastened a cast-iron plate *B*, to which are attached the shaft bearings *C*, provided with double grinding wheels to accommodate two men. A machine with one wheel can be constructed in the same way, where there isn't much grinding to be done. The two wheels are held in place by means of large nuts with right and left threads screwed on the shaft. *D* is the upper plate, and has screwed to its under surface four long studs, each furnished with double nuts. These four studs fit in four holes drilled on plate *B*, as shown. Face *a* must be perfectly true. By means of the nuts, plate *D* can be set in such position that the two grinding wheels, which must be of the same diameter, will be tangent to the upper face *a* of the plate *D*.

When the upper plate is set properly, the four upper nuts are tightened, to keep it in the right position. Two collars, one on each side of the central bearing, keep the shaft in place. The wheels should run very true.



Front Elevation and End View of Double Surface Grinder.

Evidently any irregular surface that slides on face *a* will have its irregularities ground down. I have seen large piston rings and ring segments, badly sprung, that otherwise would have been filed or machined over again, ground easily and almost to perfection in a short time on one of these grinding machines. J. M. Menegus.

Los Angeles, Cal.

[The means provided for adjustment of the table *D* are primitive, as might be expected in a "homemade" tool, but the very fact that the adjustment is not easy to change undoubtedly is one reason for its success. The ordinary commercial grinder of this type is not a great success because of the difficulty generally found in keeping the wheel in good condition, and this is largely the fault of the operator in "monkeying" with the table adjustment so as to make the wheel cut faster. Such machines should be set so that a very thin cut is taken, and then they work very well.—Editor.]

A MILLING ATTACHMENT FOR DIE SINKING.

I enclose herewith a sketch of an attachment for milling long semi-cylindrical grooves with a vertical milling machine or die-sinker. This device is used in the die-sinking shop of a large drop-forging plant making many automobile parts, such as axles, etc.

The shaft *A* is connected to the spindle of the milling machine or die-sinker, and carries a bevel pinion *B*. This pinion drives the spur gear *D* through the medium of the bevel gear *C*. The gear *D* meshes with the teeth of the milling cutter *H*, thus driving it. In order to make the device as compact as possible, the face of the bevel pinion *B* is recessed to clear the spur gear *D*. The milling cutter has no arbor, but is carried by two gimbals or centers, *K*, of which a separate sketch is given. These, when adjusted, can be held in place by the setscrews *J*.

The whole apparatus is mounted in an extremely heavy and stiff frame, *F*, braced by arms *G* to the milling frame. This bronze frame takes the thrust of the cutter, and steadies it. The shafts run in bronze boxes with ample provision for oiling. The spur gear is also of bronze, so that by no chance can the teeth of the cutter be injured by failing to mesh with those of the gear.

The length of groove which can be milled with this attachment is limited only by the longitudinal travel of the bed of the machine to which it is attached. The writer has seen grooves three feet in length which were the work of this appliance. Previous to the introduction of this device into the shop, it was customary to rough plane the grooves, and then

finish them by clipping and filing, a laborious and time-consuming operation requiring highly skilled labor, as accuracy was necessary. "DIDYMUS."

[It is not quite clear from the letter given above whether the cutter is fed through the work axially, or in the same way that it would be in an ordinary horizontal miller. Presumably,

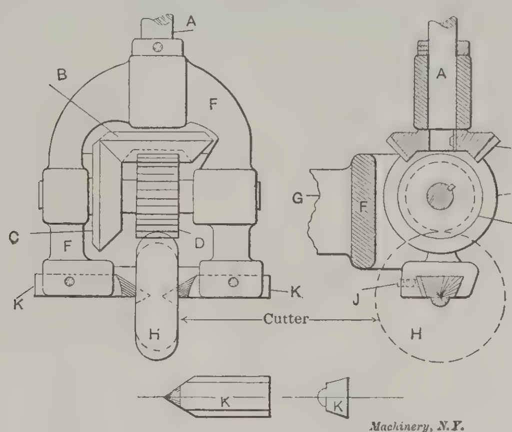


Fig. 1. Milling Attachment for Die Sinking.

however, the former method is used, since otherwise this attachment would offer no advantage over an ordinary milling machine. This device, rearranged to be driven by a horizontal spindle and thus requiring no bevel gears, has been used for many years in die-making for such work as that shown below in Fig. 2. It will be noticed that the design allows a cutter

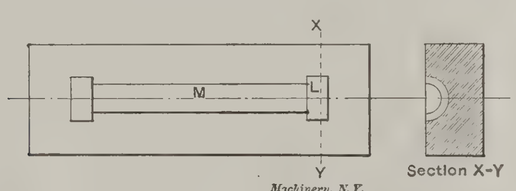


Fig. 2. Sample of Work which may be Done with the Device.

to be sunk in the metal clear to the center line. Semi-cylindrical pockets like those shown at *L* can then be easily machined in the die. The groove *M* may be afterwards either milled or planed, as desired. Other uses will readily suggest themselves.—EDITOR.]

AN ADJUSTABLE HOLLOW MILL.

An adjustable hollow mill is by no means a novelty for such tools were long ago put on the market by the Brown & Sharpe Mfg. Co. One difficulty with the Brown & Sharpe tool, however, is that the adjustment to an exact diameter is somewhat troublesome and requires considerable skill on the part of the workman. The hollow mill shown in the cut, Fig. 2, was made to simplify the matter of adjustment and its construction is plainly shown in the line cut, Fig. 3. The adjustment is effected by a threaded ring, *A*, which is bored out conical at the front end where it bears on the ends of the

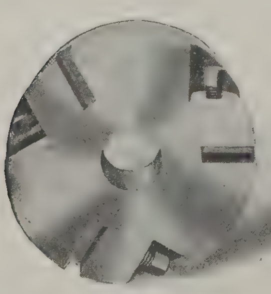


Fig. 1. Jig for Grinding Blades.

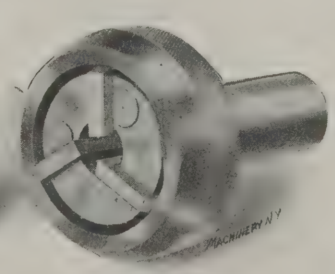


Fig. 2. Improved Adjustable Blade Hollow Mill.

cutting blades. The position of the three blades, *C*, is such that their cutting edges are radial and they are clamped with bolts, *B*, with nuts at the back in a similar manner to the regular Brown & Sharpe tool. The ring not only effects simultaneous adjustment of the blades but prevents them working out in case the clamping bolts loosen.

It is important when the blades are reground that they all be ground to the same length. For this purpose the jig shown in Figs. 1 and 4 was made. The blades are clamped in the three slots by the setscrews shown, being reversed so that the bevel ends rest on the cone piece *A* and this of course puts the cutting edge out; they are then sharpened exactly the same as a cutter with inserted teeth, the sharpening of the edges taking place on the cylindrical surface as well as

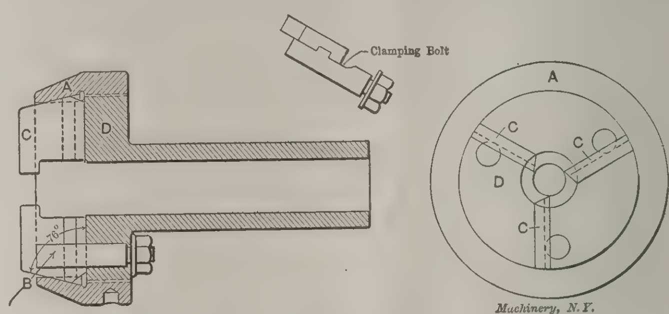


Fig. 3. Construction of Hollow Mill.

on the face. The grinding operation is effected by mounting the jig on a mandrel and treating it the same as an inserted tooth cutter, as already stated. It is quite evident that all the blades must be ground to the same length in this manner and when mounted in reversed position in the tool-holder they will all stand with the cutting edges the same distance from the center of the tool. OTTO ECKELT.

Berlin, Germany.

BOILER HORSE POWER FOR STEAM HAMMERS.

In the March issue of MACHINERY there is a communication giving rules for finding the capacity of steam hammers, and the horse power required for operation. Outside of the question of the kind of steam hammer in use—whether one in which the steam merely lifts the tap, which latter operates on the work only by its own weight, less friction, or one in which there is a direct blow caused by live steam on the upper side of the piston—there is a much more important question, as to what the "horse power" of a boiler really is. The hammer certainly exerts a definite horse power; that is, there is a certain weight lifted a certain number of feet in a minute, or a certain number of pounds pressure exerted through a certain definite distance per minute; but the same boiler will do different amounts of work in the two different types of hammer, or to put it the other way, the two different types of hammer, rated at the same capacity in pounds, will get dif-

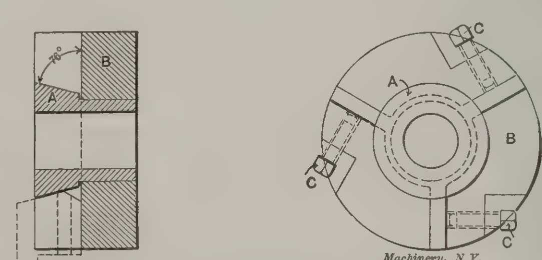


Fig. 4. Construction of Jig for Grinding.

ferent amounts of work out of the same boiler—that is, one type will work at its rated capacity with a boiler which can not supply the other.

And as to the "horse power" of a boiler, that is the worst kind of a misnomer—one engine will get three times the horse power out of a given boiler, that another will; and a duplex steam pump or a steam hammer will take many times more steam to exert a given horse power, than any engine in use to-day.

Another question comes in, as to what "constantly" means. One hammer is running "constantly" when it is making ten strokes a minute and another will take a hundred and fifty strokes to be entitled to be working "constantly"—this, independently of pauses. The same hammer, rated in pounds of blow, will have to work twice as fast on one kind of work, as on another.

The rule seems to me to be something like the way to get the weight of a pig by balancing him against a stone and guessing at the weight of the stone. ROBERT GRIMSHAW.

Hanover, Germany.

CHANGING DRAWINGS.

Probably one of the most important problems coming up to draftsmen in general, is making changes on drawings. The changes I particularly refer to are those required in shops manufacturing standards, when some fellow comes along and wants his order filled a little different. He just changes from the standard enough, probably, so that the original drawings cannot be used, and then it's up to the draftsman to make a new drawing or change the original. As the original is standard, it is not desirable to make erasures on it; therefore, the problem is at hand. To make a new drawing would require a lot of time, and as time is money with the boss, it is our duty to devise some means of saving it for him. A method for doing this which I have found that reduces expenses to a minimum may be briefly described as follows:

From the original drawing make a brown print, using a thin, tough paper. This gives a print with clear white lines on a brown background, the brown being impervious to light. Paint out on this print, with ordinary drawing ink, the lines not desired on the changed drawing, after which make a second brown print from the first. The print thus obtained has dark brown lines on a white background. Draw in on this print the changes and you have the new drawing desired, from which blue prints can be made.

The writer has used this method for some time and finds it a very desirable one. G. L. P.

TO DETERMINE THE ANGLE OF A DIE-BLOCK SLIDE TO MATCH THE KEY.

There appears to be a mistaken idea regarding the taper of die-blocks and their keys. It is quite common to see drawings with the same taper per foot indicated on each. This is not correct, and in cases where they are so marked it always requires an extra fitting of the key.

From the sketch it can be seen that when looking at the key in the position marked *A* the normal taper is apparent,

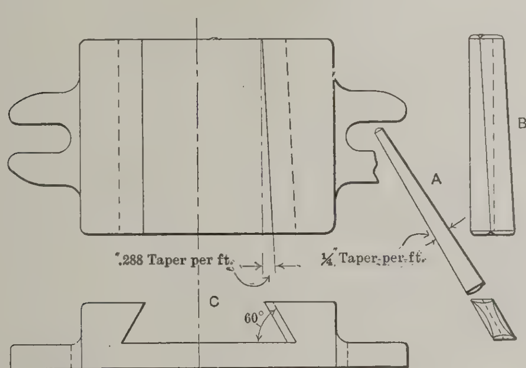


Fig. 1

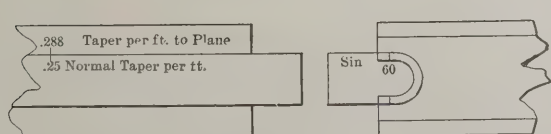


Fig. 2

Variation in Angle of Die Block Slide Due to Angle of Key.

but when viewed as in position marked *B* it assumes an oblique position which makes the angle in the die-block differ from that of the key.

The angle of the die-block can be found by dividing the normal taper per foot of the key by the sine of the angle of the slide. For instance, taper per foot of key is 0.25, the slide is 60 degrees and the sine 0.866; therefore $0.25 \div 0.866 = 0.288$ inch, which is the taper per foot of the die-block. To avoid questioning in the machine shop, it is well to state that the 0.288 inch taper per foot is equal to the normal taper of ¼ inch per foot of the key.

Although alluding principally to die-blocks and their keys, it is of more importance that machine slides and their taper gibs should be dimensioned correctly, as they (especially long ones) are not so easily fitted.

The method of making this calculation on the slide rule is also shown. Set rule to the sine of the angle *c* and set the runner on the scale *B* over the normal taper per foot of the gib or key, and on scale *A* read the taper, to which plane the die-block. The difference in angles is more noticeable as angle *c* decreases; for instance, should it be 20 degrees and the taper of the gib remain 0.25 inch per foot, the angle for planing would be 0.731 inch per foot. WINAMAC.

PRACTICAL SYSTEMS.

Manufacturing establishments of the present day are run to make money and not for the purpose of affording lucrative positions wherein men can show to the world what brilliant talent they possess. It matters not how much of a genius a man may happen to be, or what his scientific attainments are, if they cannot be utilized for the practical results that are required and for the financial gain and benefit of the man or the concern which employs him. Results count, and if one man cannot produce them he is likely to be turned down in favor of a man who can.

The up-to-date manager, eager to make a good record and to have the business of the establishment of which he is the head, come out on the right side of the ledger at the close of the year should not be misled by the man with the brand new system, the like of which was never before seen or heard of; that will produce such astonishing results; that will fill the office with an expensive lot of filing cases, cards, blanks, charts, and other marvelous devices, and such an elaborate and intricate method of indexing, filing and handling the information derived from a mass of technical reports ornamented with symbols and strange hieroglyphics, and received every ten minutes from all parts of the plant, until it requires an extra dozen clerks to run the thing and gives him such a mass of figures and scientific deductions about a whole lot of things that he doesn't want to know and hasn't time to wade through if he did. But what he wants to know is: How much consumable supplies cost last month; why they cost 20 per cent more than the month before; what was the cost of the stock used on that job for Billings; why did Johnson's job get "hung up" for three weeks; how does it happen that there are five idle machines in Smith's department when an order from Jones has been in the office for a week that might just as well have been pushed along on those idle machines; why Robinson is getting just the same pay as Oliver and turning out only about half the work; why Porter's name did not get on the pay roll and no one in the office knew anything about him until he turned up on pay day.

When to get these and a thousand other practical items of information that are needed every day, but that the new-fangled and technically elaborate system does not give, he has to go out in the shop, just as he used to, and dig out the facts for himself, it is high time to get down out of the clouds, have a house-cleaning and get a system that will tell what he wants to know, and tell things pretty soon after they happen, and tell wrong things before they have an opportunity to happen at all; not minding about the more theoretical matters, however alluring it may seem from the scientific or technical aspects of the system, because if it does not produce practical results and give, not only a detailed but a comprehensive idea of what is going on in the establishment, from the office to the shipping room, it is not wanted and the practical business manager cannot afford to have his administration loaded up with it.

This is not a tirade against systems, as such, but is just a few remarks in reference to the impractical systems that one finds in some of the would-be-up-to-date establishments of to-day; against the conditions in this respect which may be well described as system gone to seed. A proper, practical system, devised to suit the local and individual conditions, which have been carefully studied, comprehensively considered, and the

means adopted to suit their peculiar needs, is all right and cannot be too highly commended.

"Red tape" is good when we use the expression as meaning that condition wherein the business is transacted through regularly authorized channels, by properly authorized methods, and the transactions noted by correct records, but when the "red tape" is used for the sake of having "red tape," then it degenerates into what we might call "green tape," and the sooner we drop it the better it will be for the welfare of the business, the pocket of the owner, and the reputation of the manager.

Neponset, Mass. OSCAR E. PERRIGO.

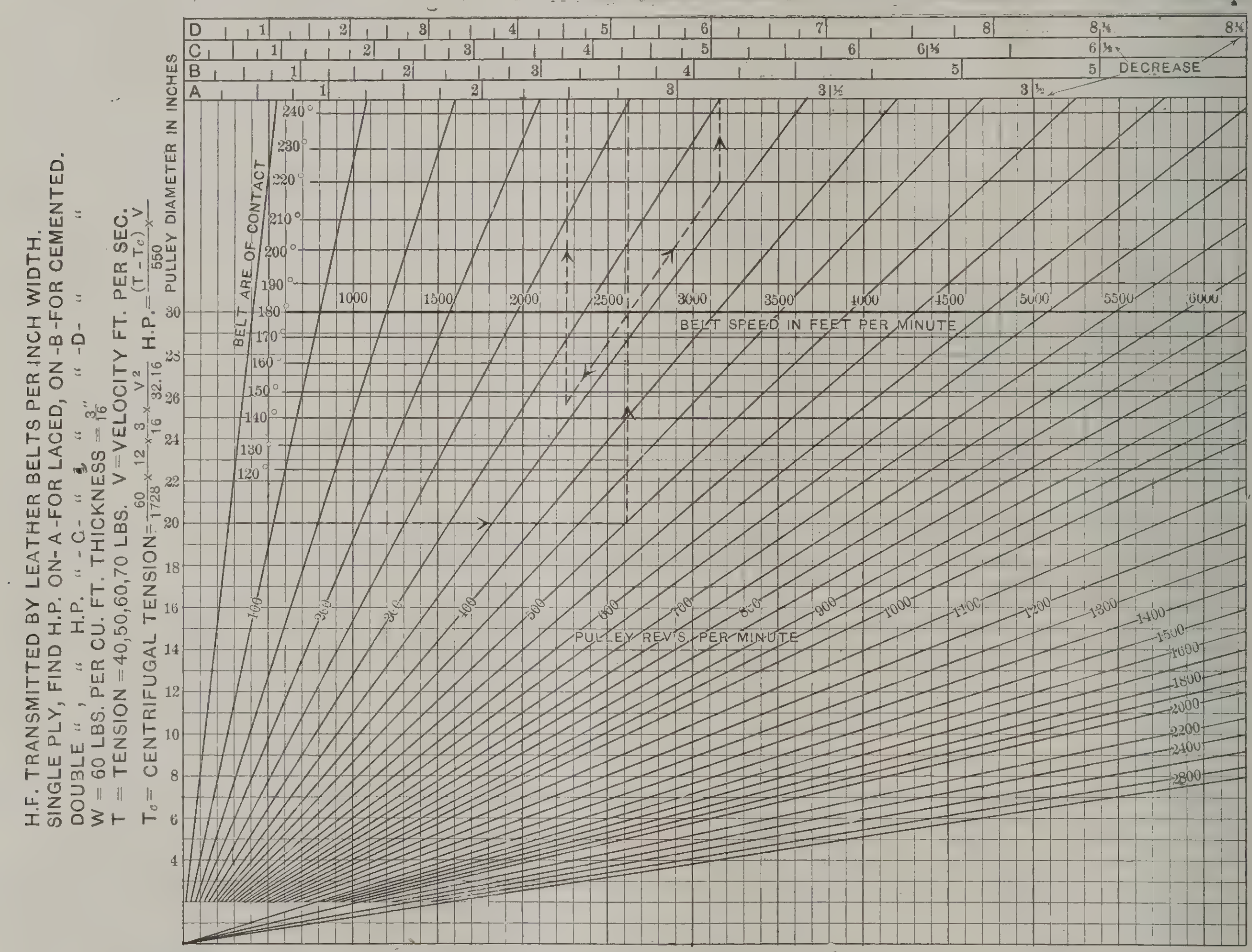
HORSE POWER TRANSMITTED BY LEATHER BELTS PER INCH OF WIDTH.

In laying out a diagram for the horse power of belting, the points to be considered are: pulley diameter, pulley revolutions per minute, belt speed in feet per minute, belt arc of contact, centrifugal tension of belt, and the belt itself. To my mind the ideal diagram should contain all of these. In the past many diagrams have been published but none, which have come to my notice, seem to fill all the conditions. One of the best was the one of Prof. J. J. Flather, published as a supplement to Machinery in March, 1900, but even this one does not start with diameter of pulley and number of revolutions. The belt speed must be known. Taking the illustration as shown by dotted lines in Prof. Flather's diagram, one must make four movements to find the horse power when the belt speed and arc of contact are known. This seems to me unnecessary. With a belt contact of 180 degrees it should be possible to read the horse power direct from the belt speed. With any other arc of contact one additional movement ought to give the desired result. A diagram to be complete should also give all data upon which it is based, for in many cases a range of sizes, etc., which will answer in nearly every case will not do for some special case which may be needed, and, as is common with most special cases, needed in a hurry. For instance, leather belting is met with most frequently, but a case may arise where camel's hair belting is specified, and the weight and tension given.

Among all the diagrams which I have collected, I have been unable to find one which would answer all the conditions arising in my work. For the benefit of others who may be in like predicament, and for those who may be interested in the subject, I submit a diagram of my own which, so far, has proved very satisfactory to me and to those to whom I have given copies.

Referring to the diagram, it will be seen that with the belt speed given the horse power for single or double, laced or cemented belts can be read directly with an arc of contact of 180 degrees. Any other arc requires one additional movement, as is also the case when the pulley diameter and revolutions are given. The data are all given and may be used for any conditions outside the range of the diagram.

Bound Brook, N. J. F. W. HOWLAND.



Horse-power Transmitted by Leather Belts per Inch of Width.

[The method of using this diagram will perhaps require a little further explanation. Suppose that the problem is to find the horse power transmitted by a 6-inch single belt, cemented, driving a 20-inch pulley at 500 revolutions per minute; the arc of contact is 145 degrees. On the left-hand margin we read the diameter of the pulley which is 20 inches. Follow toward the right the horizontal line marked 20 to its intersection with the diagonal mark 500 which represents the number of revolutions per minute. From this point of intersection run a vertical line to the heavy horizontal line which is graduated for belt speed in feet per minute. This will be seen to be about 2,550. This vertical line may be continued to the top of the diagram across the four scales *A B C D* shown there. In accordance with the directions at the left of the diagram *B* is the scale we use for a single cemented belt. The vertical line, continued to the scale *B*, gives us about 3.6 horse power per inch of width of belt. This result, however, is true for an arc of contact of 180 degrees only, for any other arc of contact we must make a correction. Our problem

requires an arc of 145 degrees. From the point of intersection of the vertical line with the heavy horizontal line on which are marked the speeds in feet per minute, run a diagonal line toward the lower left-hand corner, as shown by the dotted lines. At the point where this diagonal line intersects the proper horizontal for the required arc of contact, graduations for which will be found near the left edge of the diagram, erect a second vertical line to the scales at the top of the cut. Following the dotted lines and arrows shown, this gives us on the scale *B* about 3 1/3 horse power per inch. Multiplied by 6 inches, the width of our belt, we have a capacity of $6 \times 3\,1/3$ or 20 horse power. To still further illustrate the effect of a variation in the arc of contact consider the same problem with 220 degrees contact. Continue the diagonal line drawn for the last problem in the other direction, through the horizontal graduations corresponding to 220 degrees. From the point of intersection of the diagonal and the horizontal, erect a perpendicular to the scale above. This gives about 4¼ horse power per inch on scale *B* or about 25½ horse power for a 6-inch belt. This operation is also shown by dotted lines in diagram. Toward the end of each of the four scales *A B C* and *D* will be found a figure marked "decrease." This signifies that after that point in the scale is passed further increase in belt speed per minute will result in a decreasing power transmitted, owing to the action of centrifugal force on the belt as it passes around the pulley. This has the effect of lessening the arc of contact, and the pressure between the belt and face of the pulley as well.—EDITOR.]

JIG KNOCK-OUT FOR TIGHT WORK.

I had the job of drilling some drop forgings, like that shown in Fig. 1, in a jig and had considerable trouble in getting them out of the jig owing to the chips, the forgings being a neat fit having been milled on all surfaces before drilling. There were three blind holes drilled in these forgings and the chips would rest on the bottom of the holes and stick up into the jig locking the jig and forging together so that it was necessary to drop the jig on the floor each time to jar the forging loose. I soon got tired of this performance and devised the fixture shown in Figs. 2 and 3 to loosen the forgings after drilling.

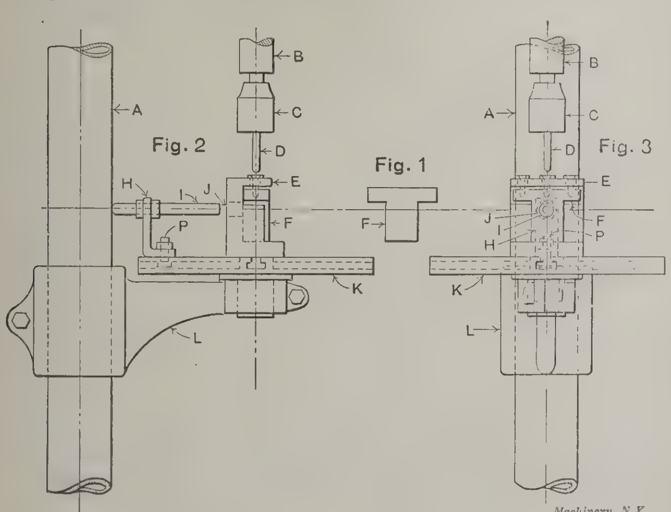


Fig. 1. Forging to be Drilled. Figs. 2 and 3. Front and Side of Drill Press with Knock-out Attached.

Figs. 2 and 3 show the front and the side of the drill press with the fixture for removing the work from the jig. *A* is the drill press column, *L* is the table bracket, and *K* is the table supporting the jig *E*, in which is the drop forging *F*. This forging was clamped in the jig by a clamp, not shown, which encompassed the front of the forging and the back of the jig. A hole, *J*, was drilled in the back of the jig and an angle-piece, *H*, was bolted to the table in which a rod, *I*, was secured by nuts. The hole, *J*, was drilled at such a height that its center was of the same height as the hole in *H* and was made considerably larger than the rod so that there was no trouble in entering it when loosening the forging. To remove the work after removing the clamp the operator takes hold of the jig on each side and shoves it back so that the rod *I* enters the hole in the back of the jig, striking the work and pushing it out. This is much better than dumping the jig on the floor and lifting it back again for each piece.

Philadelphia, Pa. C. W. J.

EXPANDING LATHE MANDREL.

The expanding lathe mandrel shown in section in Fig. 1 is one that was made for turning the shells down in Fig. 3. These, as it will be seen by referring to the dimensions, are very light and thin, the finished thickness or the wall being only 3/16 inch. The body of the mandrel is made of a casting, *A*, which is squared at one end, *G*, for the lathe driver and

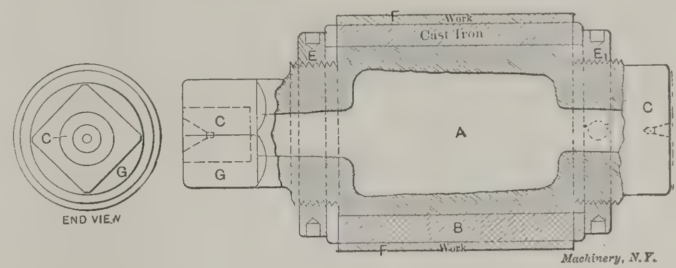


Fig. 1. Expanding Mandrel for Turning Shell.

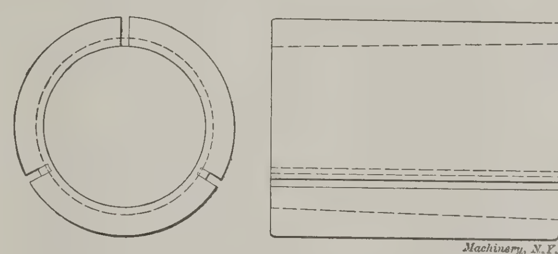


Fig. 2. Bushing Used with the Mandrel.

threaded at each end for the nuts *E* and E_1. The body of the mandrel is turned to a taper of about ¾ inch to the foot, and on this part is fitted the cast iron expanding bushing, *B*. This bushing, shown in Fig. 2, has three longitudinal cuts evenly spaced on the periphery, and one of the cuts goes through to the bore. The ends of the arbor, *A*, are bored out and hardened steel centers, *C*, are fitted therein in which are carefully reamed centers. A spanner is provided for tightening and loosening the nuts *E* and E_1, which is necessary, of course, when putting on and removing the work, *F*. The arbor is driven by the driver shown in Fig. 4. This screws on the lathe spindle and has a square hole cored in the end for the reception of the squared end on the arbor. This arrangement makes a very neat and compact drive and one which, if prop-

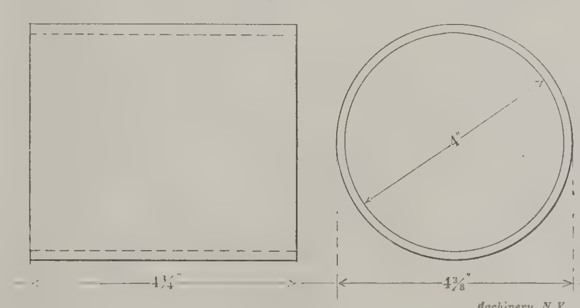


Fig. 3. The Bushing which is to be Turned.

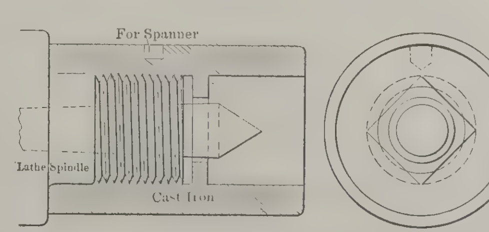


Fig. 4. Driver for the Taper Arbor

erly made, drives the arbor from all four corners of the square and in this manner avoids the tendency to eccentricity which is always present when the work is driven by a single-tail dog.

W. T.

CARD INDEX FOR DRAFTING ROOM.

The card index system has proven a valuable aid in facilitating the drawingroom work, most particularly for keeping track of drawings of varying kinds and descriptions. However, it is apt to become rather voluminous if the business is a growing one, and even though one may add all the card-index guides possible, dividing the index into classes and subdivisions, there will invariably be some sub-divisions that will contain more cards than are convenient to look through every time a drawing is to be found.

For this reason I thought it appropriate to give a sample of a card that will make the index less voluminous, and at the same time permit a saving of time when looking up a drawing. It has been the usual practice to make one card for each drawing indexed. This is, however, not necessary as long as there will always be a certain number of drawings of the same kind of tools or articles that can conveniently be listed on the same card. The card depicted shows plainly the principle employed in regard to using the index guides, having first guides for general classes, and then for subdivisions. On the third

CLASS ....Milling Machine Fixtures.
SUBDIVISION. .Fixtures for parts of Multi-spindle Drills.

FIXTURES FOR FEED RACKS.

No. of Drawing.	Date Issued.	Draftsman..	Description.	Date Superseded
2716	6-13-1904	Smith	For 4-spindle drill, 1⅜ center-distance.	12-31-1905
3563	9-27-1905	Leland	For 3-spindle drill, 1⅜ center-distance.	....
4716	12-30-1905	Leland	For 4 spindle drill, 2½ center-distance.	....
4719	12 31-1905	Leland	For 4-spindle drill, 1⅜ cen ter-distance.	....

Arrangement of Drawing Card to Save Space.

line of the card is given the general name of the class of articles for which the drawings on this card are made. The remainder of the card can be used for filling out from time to time additional drawings belonging to this same general description. It will be seen that by means of this system the card index can be easily reduced to a fraction of its original volume. As the draftsman is well aware, the average life of a drawing is rather short and still, as superseded drawings have often to be referred to, it is well to systematize the drawing room so that the superseded drawings are kept on file right with the regular ones, but marked "superseded," and with the date the reissue took place. In order to save unnecessary delay in looking up a drawing the date when the drawing was superseded should also be marked on the card in the index. With the exception of these remarks the picture of the card will explain itself, and I hope it may prove a time-saving suggestion to some drawing rooms that work under difficulties with rapidly expanding card-index systems.

Hartford, Conn. ERIK OBERG.

STIFFENING A LONG BORING BAR.

When using a boring bar to take heavy cuts in deep holes, it is impossible to hold the tool with any degree of rigidity by the means ordinarily used. The boring bar is so long that it has tremendous leverage on the comparatively narrow boring surfaces of the compound rest and the main slide rest. The more joints there are in the tool post and slide the worse the conditions become. The accompanying sketch shows an arrangement which may be used to relieve the slide rest bearings of the greater part of the strain, holding a bar very rigidly and doing away with chatter, no matter how heavy a cut is being taken. The device was adopted primarily to avoid the breaking of the dovetail on the tool slide and compound rest.

D is a boring bar held in a tool post *E*, whose construction is clearly shown in Fig. 2, although its exact design is immaterial to the success of the device described. *F* is a stiff

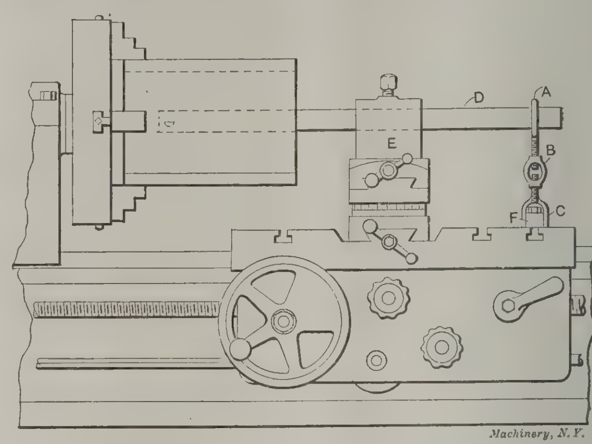


Fig. 1. Stiffening a Long Boring Bar.

steel bar provided with two bolts *G* by which it is fastened in the T-slots of the carriage, as shown in Fig. 1. *A* is an I-bolt, forged of ⅝ stock, which encircles the boring bar. A similar I-bolt *C* is adapted to encircle the bar *F*. These two bolts are connected by turn buckle *B*, and this is screwed up

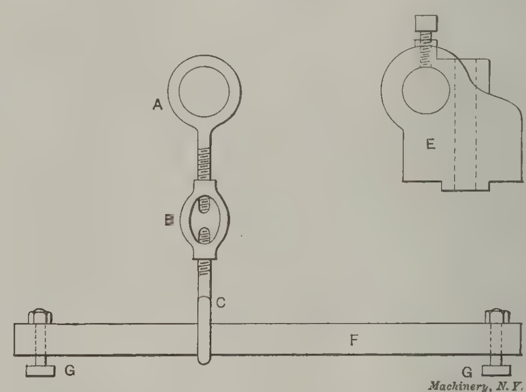


Fig. 2. Details of the Attachment.

until the parts are in tension, thus relieving the bearing surface of the slide rest of the bending strain due to the cut at the front end of the bar. ALBERT ANDREWS.

Chicago, Ill.

* * *

FRENCH RULES FOR ABBREVIATIONS OF METRIC SIGNS.

The French minister of public instruction has decided that all teachers throughout France are in future to employ the following distinctive abbreviations for the various weights and measures For denoting length—myriameter, Mm.; kilometer, Km.; hectometer, Hm.; decameter, dam.; meter, m.; decimeter, dm.; centimeter, Cm., and millimeter, mm. For areas—hectare, ha.; are, a, and centiare, ca or m². For measures of bulk (timber, decastere, das; stere, s or m³, and decistere, ds. For measures of mass and weight—tonne, t; quintal metrique, q.; kilogramme, kg.; hectogramme, hg.; decagramme, dag.; gramme, g.; decigramme, dg.; centigramme, cg., and milligramme, mg. For measures of capacity —kiloliter, kl.; hectoliter, hl.; decaliter, dal.; liter, l.; deciliter, dl.; centiliter, cl., and milliliter, ml. The use of capital letters for the three largest denominations of length are intended to prevent confusion, and all the other abbreviations follow on uniform lines. The employment of full stops between the letters is officially abolished, and k. g. for kilogramme and m. m. for millimeter disappear.

* * *

The city of Berlin has a very extensive system of pneumatic tubes for the handling of mail. The total length of the tubes in 1896 was 42 miles; in 1900 this had reached 47 miles, which was increased to 75¾ miles at the end of 1904. Sixty-nine stations are served by this system.

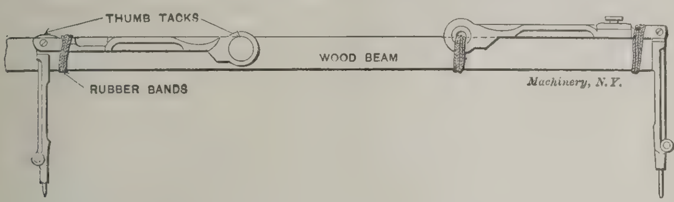
SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

A SHORT ORDER BEAM COMPASS.

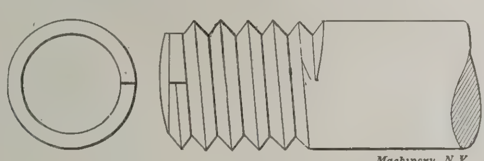
A friend of mine, having need of a beam compass in a land where there was none, hit upon a scheme as illustrated by the sketch. He dismantled the compass belonging to his drawing set and fastened the needle-point end firmly to a stick about one-half inch square, and of the desired length. This fastening was accomplished by first notching one side of the stick to admit the hinge of the compass leg, so it might lie squarely



on top, and tying it with stout cord. The pencil leg was fastened by a thumb-tack through the eye, another on top to prevent "back-lash," and some rubber bands. This part, by the way, was placed at the side and not on top of the beam. The radius was easily adjusted by removing the two thumb-tacks and sliding the pencil leg to the right location. Once constructed, the compass worked as well as an expensive beam compass. BESSEMER.

TO PREVENT "CROSS-THREADING."

I want to tell you of a way to prevent "cross threading." The first turn of a thread on a screw, and in a nut also, begins at nothing, at the bottom of the thread, and increases gradually, for one turn, to a complete thread. Take a file and chisel, and cut away this imperfect beginning of the thread up to where the full thread begins, both in the screw and nut. They will then always "start" right. It is the



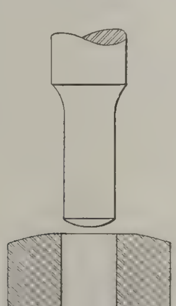
gradual increase at the beginning that allows the thread to get wedged at an angle and the screw and nut to become what is known as "cross-threaded."

Try this on your lathe chucks, etc., where it is an advantage to have the threads start easily, and where "cross-threading" might injure a fine tool; also on pieces of large diameter, with fine threads, which are difficult to start properly, such as unions and other large pipe fittings.

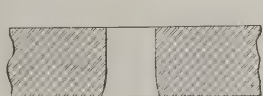
Beverly, Mass. C. E. BURNS.

PUNCHING HOLES THROUGH THICK METAL.

Some very interesting ways of doing work may be seen in agricultural implement factories; for instance, one piece made in such a plant is a piece of steel about 3 feet long, 2 inches



POSITION OF PUNCH AND DIE



SHAPE OF HOLE PUNCHED

wide and ⅜ inch thick at one end gradually increasing to ¾ inch thick at the other end. This piece is punched full of 7/16-inch holes. Most people will tell you that holes cannot of the punch. The tools used on this job are shown in the accompanying cut.

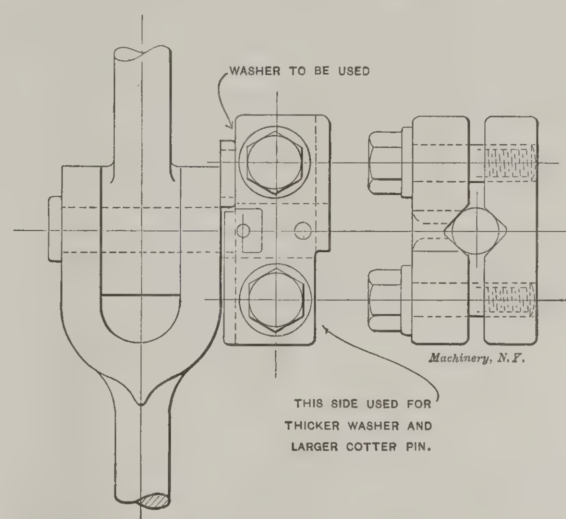
The punch was ground rounding at the end instead of square across and it was not allowed to enter the die by about ⅛ of an inch. For a 7/16-inch punch the hole of the die is made considerably larger, about 31/64 in this case. This makes a hole somewhat bell-shaped, as shown in the cross section.

In one place where I worked the punches were forged, not turned. The operator of the press touches the punches up on the emery wheel after they are tempered and they are then ready for use. My experience has been that a forged punch, especially one made by drop or die forging process, is superior to one which has been turned to shape. The dies are machined in the usual way. A. D. KNAUEL.

Moline, Ill.

JIG FOR DRILLING COTTER-PIN HOLES.

A jig for drilling cotter-pin holes is shown herewith which facilitates the operation as compared with the way it is commonly done. It consists of two pieces of steel forming a clamp, each piece having a V-groove to receive different diameters of studs. The upper one contains two holes which correspond with the size of cotter pins desired. Should more than the two sizes be required, extra top pieces can be used with



the same bottom piece. Part of the upper piece is cut away on each side on a line with the edge of the holes, which allows the washer to be used to be inserted therein and the jig then clamped in position. By this means no scribing or spotting is necessary and a much better job can be done. Although it is shown it is obvious that the male portion of the joint need not be in position when drilling. WINAMAC.

MAKING METAL FILLET.

I had occasion about a month ago to make several metal patterns and, not being able to procure metal fillet that would come up to my requirements, I decided to make it myself. I took some old three square files, ground off the teeth and then ground them to the shape of the fillet that I wanted. I took a piece of good high-grade tool steel and drilled holes just large enough to broach out to the form of the punch. The punch was made slightly tapered and I used one for about three holes, punching each hole a little deeper than the other. The draw plate was then hardened and tempered to a light straw. The fillet made in this way was quite small as I did not require a large size. To make a large fillet in this way would require the use of a draw bench strongly geared. For my use draw tongs and a bench vise did very nicely.

New York. L. I. ROSENTHAL.

* * *

The report of tests made on the cork insert friction surfaces of the brake and clutches made by the National Brake & Clutch Co., Boston, Mass., mentioned in the business notes of the July issue, should also have stated that the average coefficient of iron surfaces is 0.16 and for bronze, 0.14, under the same conditions which gave 0.33 to 0.35 with the cork insert surfaces.

SHOP RECEIPTS AND FORMULAS.

A DEPARTMENT FOR USEFUL MIXTURES.

This page will be used for the publication of shop receipts which the contributors know from experience to be practicable. Nearly all readers of MACHINERY can add something, and it is desired that they use this page as a medium for exchanging useful formulas. It makes no difference if they are old and supposedly well-known, provided they have not already appeared in this department.

228. IMPERMEABLE CEMENT FOR PIPES.

To make an impermeable cement for steam, air and gas pipes mix thoroughly powdered graphite, 6 parts; slaked lime, 3 parts, sulphur, 8 parts, and boiled oil, 7 parts. The mixture must be thoroughly incorporated by protracted kneading until it is perfectly smooth and free from lumps.

Dayton, Ohio. O. E. VORIS.

229. OIL FOR USE IN MICROMETER SCREWS.

To prepare oil for micrometers, fine mechanism, etc., take neatsfoot oil and put into it some lead shavings in order to neutralize the acid contained in the oil; let this stand for a considerable time, the longer the better. Oil thus prepared never corrodes or thickens. JOSEPH M. STABEL.

Rochester, N. Y.

230. SOLDER FOR GOLD.

To make a solder for gold melt together in a charcoal fire 24 grains gold, 9 grains pure silver, 6 grains copper, 3 grains good brass; this makes a solder for gold ranging from 12 to 16 carats fine. For finer gold increase the proportions of gold in the composition. To make it darker in color lessen the proportion of silver and increase that of copper.

Rochester, N. Y. JOSEPH M. STABEL.

231. TO ANNEAL FINISHED COPPER.

To make a mixture for protecting finished copper pieces which require annealing mix to a thick consistency white cold water paint and alcohol and apply to the copper with a brush. Allow the mixture to dry and then heat to a low red by dipping into pure melted lead at the required temperature. Cool in air or water, preferably the latter. L. C. CARR.

Lynn, Mass.

232. FOR GLUING EMERY TO WOOD OR METAL.

The following is a good receipt for gluing emery to wood or metal and I have used it with success where other cements have failed. Melt together equal parts of shellac, white rosin and carbolic acid (in crystals) adding the carbolic acid after the shellac and rosin have been melted. This makes a cement having great holding power. W. T.

233. BELT DRESSING.

I have found the following mixture to answer the purpose of a good belt dressing as well as an excellent anti-slip medium for hard-worked leather driving belts: Russian tallow, 1 ounce; best lard oil, 2 ounces; Venice turpentine, 16 ounces. This dressing is good to use on the belts of belt-driven motor cycles. W. R. BOWERS.

Birmingham, Eng.

234. LUBRICANTS FOR USE IN CUTTING BOLTS AND TAPPING NUTS.

Mineral oils should never be used in thread cutting and tapping, as they do not generally flow freely enough. An excellent solution for this purpose can be prepared by dissolving 1½ pound of sal-soda in 3 gallons of warm water, then adding 1 gallon of pure lard oil. This is known as a soda solution. Pure lard oil is the best for fine, true work.

Urbana, Ill. T. E. O'DONNELL.

235. VARNISHING BLUEPRINTS OR DRAWINGS.

The appearance of varnished blueprints and drawings may be greatly improved and the amount of bleached shellac varnish considerably decreased by the following process: Soak over night a quantity of isinglass in just enough cold water to cover it. Use a perfectly clean glue kettle, in which it is to be heated up, adding whatever amount of water may be needed to make a moderately thin sizing. Apply this warm, *not* hot, to the drawing or blue print. When dry apply one good coat of bleached shellac varnish. The effect will be nearly as good as the best varnished maps. OSCAR E. PERRIGO.

Neponset, Mass.

236. MOLDING MIXTURE FOR RUBBER STAMPS AND PATTERNS.

The following mixture is one which can be used for making molds for rubber stamps, or special shapes of rubber, or for complicated, odd, or queer shaped patterns, of small size, as the working must be done inside of ten minutes, and the surface takes a finish as smooth as glass if well rubbed. If an impression is to be made, the surface of the type or article to be impressed should be rubbed with a solution of kerosene, and graphite. Plaster paris, 5 pounds; French chalk, 2 pounds; china clay, 2 pounds; dextrine, ½ pound. Mix with dextrine water, which is made by dissolving 1 pound of dextrine in one gallon of water. FRANK G. STERLING.

Lowell, Mass.

237. WASHING OILY WASTE.

The following is an excellent method of washing oily waste. The chief objection to most of the common methods employed is that the waste, after being dried, is found to be matted and of a hard, gritty texture. The common method of washing the waste, using sal-soda in solution, is a good one, as far as the cleaning qualities are concerned, but it leaves the waste hard and matted, so that it is difficult to handle. A simple remedy for this is to rinse the waste (after being cleaned in the sal-soda solution), in very hot water, to which has been added a quantity of liquid ammonia. This will render the waste soft and light when dry.

Urbana, Ill. T. E. O'DONNELL.

238. A NICKEL BUFF.

For buffing nickel work, there is nothing that will give a luster equal to Vienna lime composition. It can be made by the user, but it is more satisfactory to buy it of the manufacturer, as when homemade it air-slacks very rapidly; it is put up by the makers in air-tight cans of about one pound each, and this shape will keep until used up. It is also a good buffing composition on brass or other metals where there is not much cutting down to do, as it will cut down and color in one operation. If there is much cutting down, go over the work first with tripoli, then color with rouge or lime. All these compositions are put up in different grades for fast cutting, and also for dry or greasy work. J. L. LUCAS.

Bridgeport, Conn.

239. TO WRITE ON STEEL.

Stamping tools with steel stamps will spring them and throw them out of true. Machinists should write their names on their steel tools using a fluid made of nitric acid 1 part, water 2 parts. Heat the tool gently until some wax that has been put on it melts and spreads thinly over the surface. When cold blacken the wax at a candle; then write on the wax with a steel point deep enough to touch the metal, and cover the writing with the fluid. In about three minutes wash and remove the wax. This fluid, however, will spread more or less and the writing will not be very fine. A better fluid can be made thus: Alcohol 2 parts, nitric acid 1 part, distilled water 15 parts, and nitrate of silver ½ drachm per quart of fluid. Nitric acid, however, produces vapors that are disagreeable and harmful. Chromic acid made by dissolving one part of bichromate of potash in 5 parts of sulphuric acid, for this reason is more desirable as an etching fluid, although much slower in its action. J. M. MENEGUS.

Los Angeles, Cal.

* * *

The unsettled condition of street numbers in San Francisco may be inferred from the following abstract from a letter sent to the Crocker-Wheeler Co. by their San Francisco office: "While it is not absolutely sure whether or not the number will be changed in from six months to a year, we think that our office may be considered as located at 206 First St. We have checked this matter of numbers over as carefully as possible, and we think that the above is as near as we can possibly get until the city authorities get to work and straighten matters out."

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

22. L. G. V.—Will you please tell me how to make a continuous ringing Faraday type bell; a single-stroke bell? Also please tell me how I can make a direct-current bell work on an alternating current?

Answered by Wm. Baxter, Jr.

Continuous ringing single-stroke bells are generally made by providing a clockwork to ring the bell, and a magnet to throw a catch in or out that stops the clockwork when the bell is not in use. The clockwork is wound up with a key, and will cause the bell to strike several hundred times before it runs down. A single strike bell of the type used for signalling is shown in Fig. 2. This kind of bell will strike once each time the switch is closed. It consists of a horseshoe electromagnet, *A*, which attracts the armature *B*. This armature is held on an arm that is attached to shaft *C*. Another arm on this shaft carries the bell hammer *D*. The spring *E* holds the striker in the position shown, and when the switch is closed, so as to send current through the coils on *A* the armature *B* is attracted and *D* swings down and strikes the gong. If *D* were allowed to swing freely all the way down to the gong, it would rest upon the latter as long as the switch is closed, and this would muffle the sound, hence the arm that carries *D* is made with some spring, and a stop is provided that will hold *D* just clear of the gong; then when *D* is thrown down by the pull of the magnet it will strike the gong and immediately spring back. In some cases the arm that carries

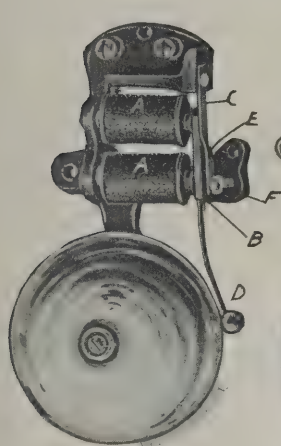


Fig. 1.

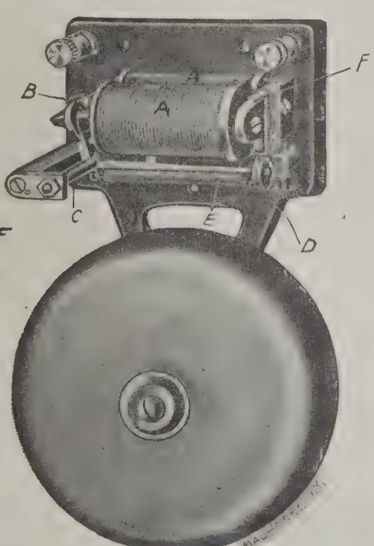


Fig. 2.

D is stiff, and the stop is made to spring. A vibrating bell is shown in Fig. 1. In this the magnet *A* attracts the armature *B*, which is supported by spring *C*, and *D* strikes the gong. The current passes through the spring *E* on the back of *B* to the stop *F* and these points separate when *B* is attracted, thus breaking the circuit and permitting *D* to swing back. The return movement of *B* brings *E* and *F* in contact again so as to close the circuit and send *B* forward once more. This action continues as long as the switch is closed. The rapidity with which *D* strikes depends upon the length from *C* to *D*. The best way to obtain the proportions of these bells is by examining one of the size you desire. They can be found in any railroad station in many designs and sizes. You cannot make a direct-current bell operate with an alternating-current.

Another Answer to Question 20.

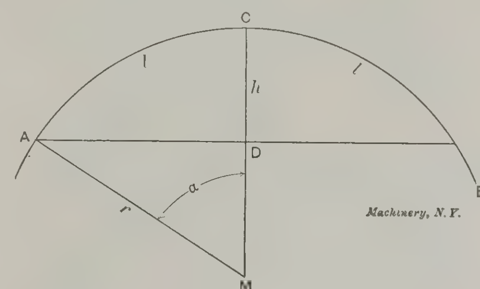
I notice in answering question 20 in the How and Why column of the July issue of Machinery, that you say you know of no method by which the radius of a circular arc can be calculated when only the length of the arc and the height of its middle ordinate are known. Though it is true that there is no formula which allows of a direct solution of this problem, yet it is easily possible to develop formulas which will lead to the desired result, and which can be solved by a method of repeated trials with little trouble and to any desired degree of accuracy.

AC is half the given arc and its length is called l, so that the length of the entire arc is $2l$. The height of the middle ordinate, CD, is called h. We know that $CD = AM \times$ versin α, and that the length of the arc $AC = 2\pi r x \frac{\alpha}{360}$. We thus have:

and

$$h = r \times \text{versin}\ \alpha \qquad (1)$$

$$l = \frac{2\pi r \times \alpha}{360} \qquad (2)$$



In these equations r and α are both unknown. From equation (2) we find by transposing that:

$$r = \frac{360\,l}{2\pi\alpha}. \qquad (3)$$

Substituting this value in (1),

$$h = \frac{360\,l}{2\pi\alpha} \times \text{versin}\ \alpha$$

If we call the value of the fraction $\frac{360\,l}{2\pi} = c$, the equation becomes

$$h = \frac{c}{\alpha} \times \text{versin}\ \alpha \text{ or } h \times \alpha = c \times \text{versin}\ \alpha \qquad (4)$$

This equation offers a solution for α by the method of repeated trial. It may be best to show by an example how this may be done.

Suppose the length of the arc is 30 inches and the middle ordinate is 4 inches; then $l = \frac{30}{2} = 15$ inches and $h = 4$. From this we find

$$c = \frac{360 \times 15}{2 \times 3.1416} = 859.41.$$

Substituting known values in equation (4), we have $4 \times \alpha = 859.41 \times$ versin α, or, simplifying:

$$\alpha = 214.85 \times \text{versin}\ \alpha \qquad (5)$$

Transposing, we find that $\frac{\alpha}{\text{versin}\ \alpha} = 214.85$. For first trial we take any number of degrees, say 30 degrees. The versed sine of 30 degrees $= .13397$, or about $\frac{1}{7\frac{1}{2}}$, so that $\frac{\alpha}{\text{versin}\ \alpha}$ is about $30 \times 7\frac{1}{2} = 225$. This is near enough to 214.85 to try this a little closer.

For this trial we use equation (5). We find that $214.85 \times$ versin $30° = 28.78$, which is not quite 30. As the versed sine increases with the angle, we now try a larger angle, say 31 degrees. We find $214.85 \times$ versin $31° = 30.68$, so that even this angle is not large enough. We try now 31 degrees 30 minutes. $214.85 \times$ versin $31\frac{1}{2}° = 31.66$. This quantity is now larger than the angle, so trying again for 31 degrees 15 minutes, $214.85 \times$ versin $31\frac{1}{4}° = 31.11$. So that 31 degrees 15 minutes is the nearest angle in quarter degrees. Of course, it would have been possible to determine the angle with a greater degree of accuracy, even to seconds by a few more trials; but this is close enough for an example. From equation (3) we find now $r = 27.501$.

A. L. De Leeuw.

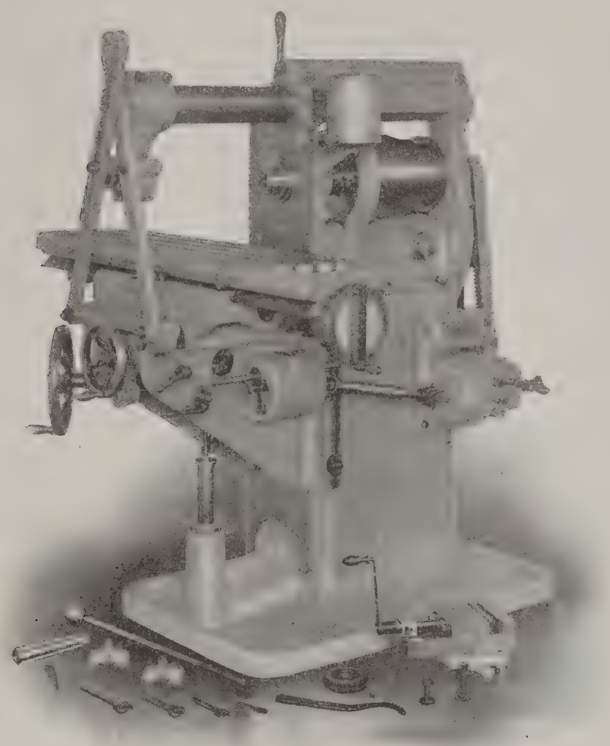
Hamilton, O.

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

ADDITIONS TO THE BROWN & SHARPE LINE OF MILLERS.

The Brown & Sharpe Mfg. Co., Providence, R. I., have recently added to their line of milling machines a plain screw feed machine which they call their "No. 2 Heavy." This machine has the same capacity as the regular No. 2: 28-inch longitudinal feed, 8-inch cross feed, 19-inch vertical movement



Brown & Sharpe No. 2 Heavy Plain Milling Machine.

of the knee. A number of changes, however, have been introduced. The knee slide on the front of the column has been extended to the top of the casting, as will be seen in the accompanying halftone. This furnishes a stiff support for the front spindle bearing and permits attachments to be rigidly clamped to the face of the column. The hand wheels for the vertical and cross movements are provided with

Fig. 1. Thompson Grinder Arranged for Surface Grinding.

Fig. 2. Table Reversed and Head in Place for Face Grinding.

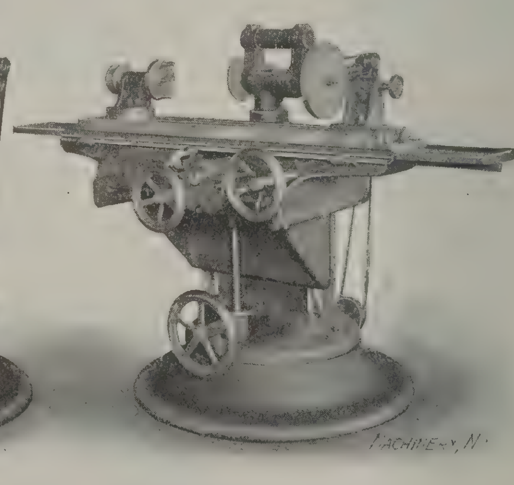


Fig. 3. Machine set up for Grinding between Centers.

clutches which can be disconnected after adjustments are made, thus doing away with the danger of accidental disarrangement of the setting, from pressing upon or hitting the handles of the wheels. The feed drive, which is of the geared variety driven by a chain from the spindle, can be disconnected from the spindle while the machine is running. Besides these changes, the machine has been made about 35 per cent heavier than the regular No. 2 machine. This weight has been so apportioned as to give the maximum amount of stiffness for the heavy service which it is intended the machine shall give.

A four-step cone is used and back gears are provided, these being inclosed in the frame under the cone. The overhanging arm is a solid steel bar, round and true, and it can be pushed back over the table when not in use. It is simply and efficiently clamped at both bearings with one lever at the front of the machine, enabling the operator to make adjustments quickly. The table has an unusual vertical depth, which provides it with a sufficient stiffness against bending strains. It has a quick return operated from the right hand end of the table by an internal gear and pinion; the table feed screw is not splined, an auxiliary shaft being provided for driving the clutch gears. The thread being unbroken, the life of the screw end is greatly prolonged and the original accuracy maintained.

With the double speed countershaft furnished there are sixteen changes of speed in geometrical progression from 13 to 439 revolutions per minute; with eight reverse speeds from 22 to 305 revolutions per minute. The speeds have twenty changes varying from 0.004 inch to 0.2 inch in one revolution of the spindle. There are no loose change gears. The machine is regularly equipped with longitudinal cross and vertical power feeds, but can be provided with hand, cross and vertical feeds when desired. The approximate net weight of the machine is 3,600 pounds. A countershaft, together with vise, wrenches, etc., as shown in the halftone, are furnished with the machine.

A similar machine of a smaller size, the No. 1½, has also been designed. This is a screw feed machine with 24-inch longitudinal feed, 7-inch cross feed, 19-inch vertical feed. This machine likewise is provided with the new features of extended knee slide, clutched hand wheels, and releasing lever for disconnecting the feed chain sprocket from the spindle while the machine is in operation. The net weight of this machine is about 2,600 pounds.

THOMPSON UNIVERSAL GRINDER.

The Thompson Grinder Co. Springfield, Ohio have recently redesigned their universal grinder. The rearrangement of this machine has been effected without altering the principle upon which the machine was originally planned. Inasmuch as the grinding spindle is mounted upon a column that is solid with the base the grinding wheels remain in a fixed position. They do not tilt, or slide up and down, or in and out. A heavy outer casing surrounds the column and carries the grinding table and movable parts. This casing turns upon the base

and neck of the column through an angle of slightly more than 180 deg. and can be clamped rigidly to the base below and the neck of the column above at any position, thus bringing the grinding table to any desired relative position to the wheel at either end of spindle. The photos herewith, were all taken without moving the camera, the different positions shown being entirely due to the turning of the casing and table about the column.

A great advantage is claimed for this principle from the fact that the work is always brought to the wheel, instead of the wheel being made adjustable in relation to the work; thus but few attachments are needed to effect the various grinding operations.

It is claimed by the makers that this machine has a larger capacity, and will do a greater range of work than any other universal grinder yet produced. The main dimensions of work that may be handled on this machine are are as follows: Knife grinding to the full length of table, 48 inches; surface grinding, 7 inches by 36 inches, is easily accomplished (see Fig. 1); cylindrical and taper grinding, 10 inches diameter by 36 inches long, on small head and tail stock (see Fig. 3); internal grinding by use of a high speed spindle, the fixture of which is clamped in the head of machine (but not shown in the cut), extends from the smallest diameter desired up to the swing of head stock, which is 10 inches; large shallow internal grinding up to 30 inches diameter by 3 inches deep, may be done by using a special headstock and allowing the work to hang over the edge of table (see Fig. 2). This last feature adapts this grinder to the use of die making and maintenance.

Strong claims are made for this machine upon the point of large capacity for every form of grinding operation. At the same time, all kinds of cutter grinding can be done quickly and conveniently as on any small machine designed especially for cutter grinding. This latest pattern is the result of constant use and severe tests for several years past.

GARVIN DUPLEX MILLING MACHINE.

The Garvin Machine Co., Spring and Varick Streets, New York, have recently built a duplex milling machine, which presents a number of noteworthy features. The most noticeable departure from the usual practice, as will be seen from the cuts shown herewith, is the method adopted for driving

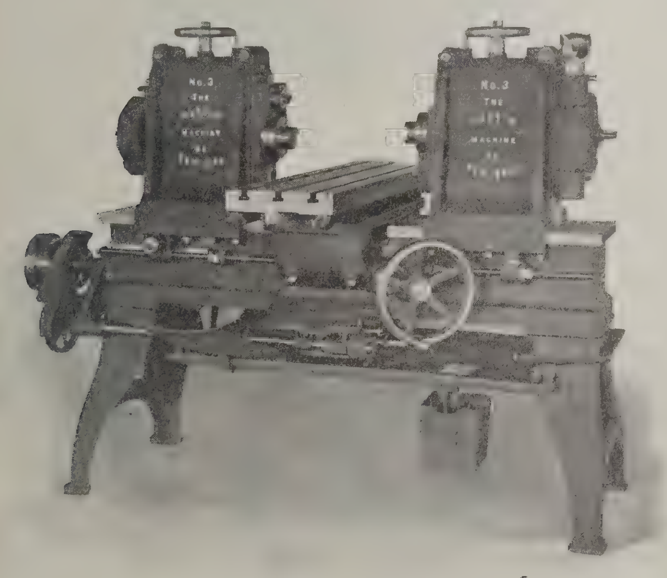


Fig. 1. Garvin Duplex Milling Machine.

the spindles, which receive their motion, not through belts as is the usual practice, but from vertical shafts with universal joints, leading from the overhead works. Another innovation is the provision of center supports for arbors for each of the two spindles, used when they are adjusted at different heights.

The line cut, Fig. 2, indicates the arrangement of the driving mechanism. The countershaft is driven by a friction clutch working within the cone pulley, which is in turn loose on the countershaft and directly belted to a corresponding cone on the main line. Two sets of spiral gears, one in each hanger, drive a pair of vertical telescopic shafts, which are below connected to steep pitch worms, running in oil, and meshing with worm wheels on the spindles. This arrangement gives a strong, positive drive, allows perfect freedom for adjustment, and avoids all belts, idlers, and tighteners.

The spindles have taper bearings and run in bronze boxes. They are carried in strongly constructed slides which have a

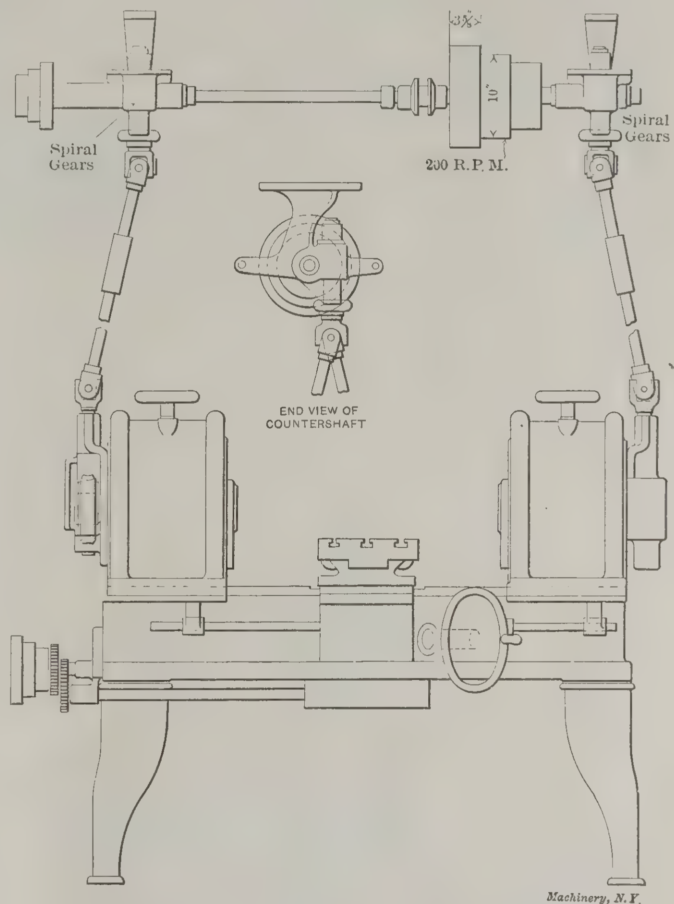


Fig. 2. Diagram showing Driving Mechanism.

vertical micrometer adjustment in the heads which carry them. Both of these heads have a micrometer adjustment along the bed, and one of them has, besides, a quick movement for running back to insert new cutters and arbors. Above the nose of the left-hand spindle, and below that of the right-hand one, will be seen in the halftone centers for the support of the outer ends of the two cutter arbors. These are adjustable within certain limits to permit a variation in the center distance between the two spindles. This arrangement permits the taking of cuts simultaneously on the top and bottom of a piece of work in cases where this is possible. Heavy cuts in steel can be taken in this way, feeding the work in between the upper and lower cutters.

The feed for the table is taken from a cone on the countershaft. The cone and the change gears furnished give twelve changes of feed. An automatic trip and reverse is provided, as well as a quick movement operated through a rack and pinion by the large hand wheel on the side. The length of feed is 42 inches; maximum distance between spindles is 5 inches; and the net weight of the machine about 3,120 pounds.

NEW HAVEN HORIZONTAL BORING MACHINE.

The New Haven Mfg. Co., of New Haven, Conn., build the horizontal boring machine shown in Figs. 1 and 2. On the bed is mounted a carriage with feeding and controlling mechanism similar to that of the lathe. At either side of the machine are mounted standards carrying the spindle heads, whose height can be adjusted to suit the position of the hole which is being bored. Between the centers of these two heads the boring bar is mounted.

This machine has a "swing" of 84 inches over the table. It takes 9 feet between the centers, although a bed 20 feet longer

can be furnished if desired, and it has a clamping surface on the table 48 inches long by 64 inches wide. The hand cross feed of the table is 52 inches. The head spindle, which has a diameter of 5½ inches, is driven by planed bevel gears. The centers for both head and tail spindles have No. 6 Morse taper. Both heads have a vertical adjustment by hand, but they can also be raised and lowered by power. A special feature of the tail spindle, shown quite clearly in Fig. 2, is that by loosening the lower bolts the spindle can be swung up out of line with the boring bar, thus allowing the bar to be removed without loosening the adjustment of the center or changing the position of the table. This is done by the hinge construction as shown. Both heads are counterbalanced. The screw cutting range is from 1 to 12 threads per inch, with feeds from 1/100 to ⅛ inch per revolution With a 16-foot bed the weight of the machine is about 30,000 pounds.

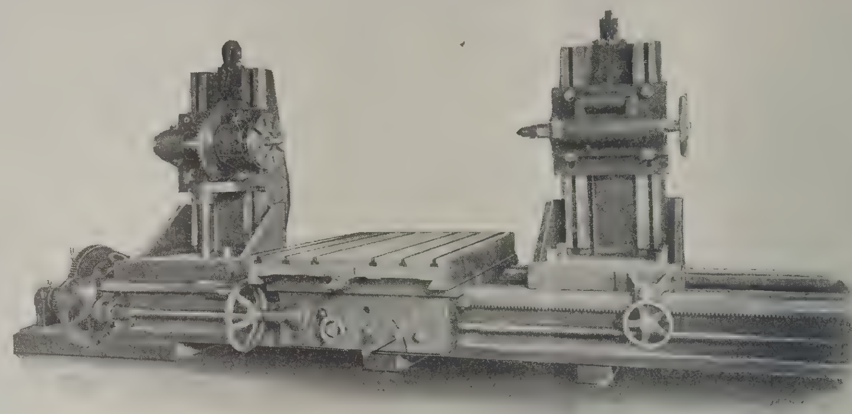


Fig. 1. New Haven 84-inch Boring Machine.

THE LATSHAW PRESSED STEEL PULLEY.

Two examples from a new line of pressed steel pulleys are shown in Figs. 1 and 2. The first halftone shows a six-arm pulley with reducing bushings removed from the hub;

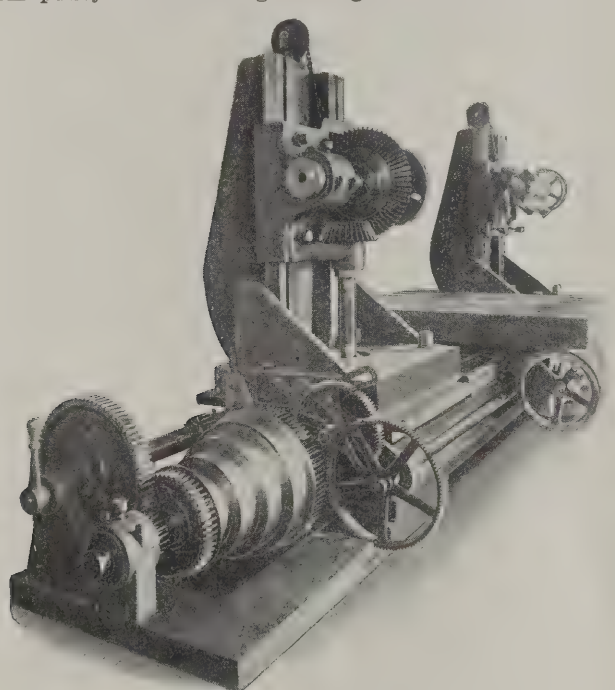


Fig. 2. Driving Mechanism of New Haven Boring Machine.

the second cut shows the double six-arm type used on the wider sizes. Larger diameters are provided with eight arms instead of six.

The pulley is of unusually simple construction. The rim

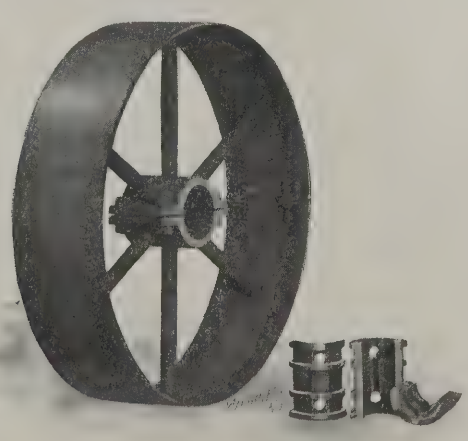


Fig. 1. Six-arm Single Latshaw Steel Pulley.

is formed of two curved sheets, bent for a straight or crowned face, as may be required, clamped together by riveted and bolted ears on the inner surface, and punched with suitable holes for the arms. The hubs are drop forgings, made by an improved process developed by the builders, which brings them so closely to size and finishes them so smoothly that no machining whatever is needed on them. These hubs are also punched for the arms, which are solid steel rods, reduced to a shoulder at the ends where they enter the rim and the hub. After being assembled with these parts, the ends of the spokes or arms are upset, and the pulley is completed.

It is claimed for this pulley by its makers, the Latshaw

Fig. 2. Six-arm Double Pulley, with Bushings in Place.

Pressed Steel and Pulley Co., Pittsburg, Pa., that this design is the simplest and strongest of any yet manufactured. The parts are few and simple, the hub is sufficiently strong to resist severe clamping strains, and has a thick enough section to be tapped for setscrews. It is furnished in all standard sizes from 12 inches to 50 inches diameter, and in all widths from 3 inches to 24 inches, crowned or straight. All pulleys over 14 inches wide have double arms, thus strengthening the rim against collapse from excessive belt pressure.

THE WIDE RANGE DRILL CHUCK.

The Wide Range Drill Chuck and Tool Co., Muncie, Ind., have brought out a drill chuck which presents a number of novel features. The design of the tool will be readily understood from the accompanying cut. Fig. 1 shows a front view of the chuck, Fig. 2 a side view, Fig. 3 is a detail of the jaw guide, Fig. 4 is a longitudinal section, and Fig. 5 is a detail of the jaws. The same reference letters are used throughout.

To the shank *A*, which is fitted to the machine spindle in the usual way, is attached the base of the chuck *B*. Two filister head screws unite this part solidly with the jaw guide *C*, which is shown in Figs. 3 and 4 in two positions, being rotated in one case 90 degrees about the center line from the position shown in the other view. This part is milled out to form seats for two jaws, *D* and D_1, which work at right angles to each other, the one in the front face and the other

in the rear face of jaw guide *C*. Setscrews, *E*, in the jaws are tightened by a square end key, onto the tool being held, which is thus clamped in the V-shaped side of the openings in the jaws. Springs *F* keep the setscrews pressed against the outer shell *G*.

The action of the device is as follows: The parts being in the position shown in the cut, screw *E* is tightened down upon the tool, which is thus centered horizontally in the V

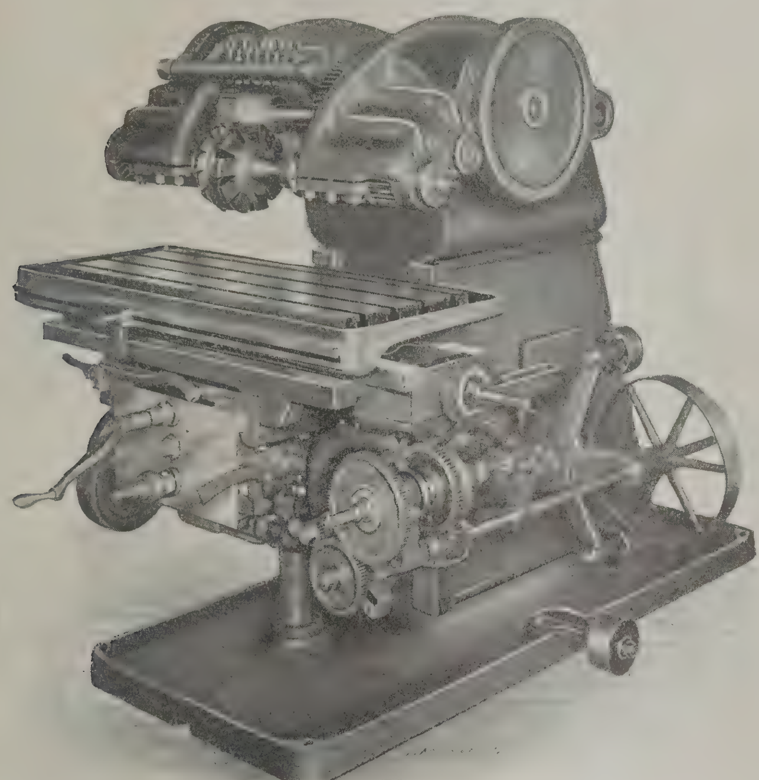
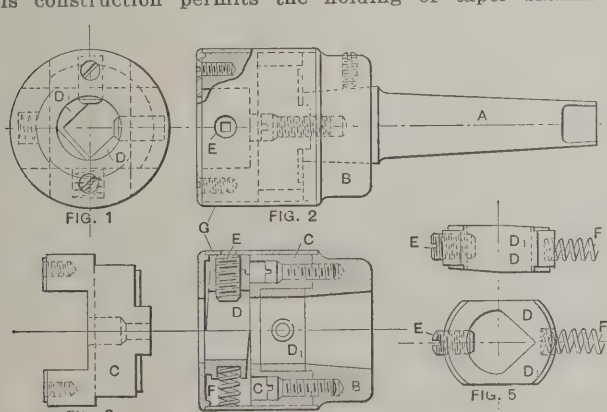


Fig. 1. Walcott Automatic Rack Cutter.

groove of the first jaw *D*. The setscrew in the jaw D_1 (which is identically similar to *D*, although located at right angles to it) is next tightened, which centers the tool vertically. The movement necessary for this last centering is permitted to the tool because, while it is tightly held in jaw *D*, this jaw itself is free to move vertically, against no other resistance than that of spring *F*; when the two screws are tightened the tool is centered and securely held. Since the two jaws are similarly placed, either of them may be tighened first. It will be noted that jaws *D* and D_1 are slightly beveled on the opposite faces, from the center line to the opposite ends. This construction permits the holding of taper shanks as



The Wide Range Drill Chuck.

rigidly and truly as straight ones are ordinarily held, the beveling of the dog permitting it to tip to one side enough to line up with the taper.

The makers have called this chuck the "Wide Range," both on account of the large tools it will take in comparison with its diameter, and on account of the fact that it will hold and center accurately any kind of a shank, straight, taper, square, a taper square, with tangs on or twisted off. It is built of steel throughout, and is made in four sizes, covering a range of from a No. 60 drill up to a 1-inch drill, or, with a No. 3 taper shank, up to 1¼ inch.

WALCOTT AUTOMATIC RACK CUTTER.

The machine illustrated in the accompanying cuts, Figs. 1, 2 and 3, is built by Geo. D. Walcott & Son, Jackson, Mich., and is an outgrowth of their "half automatic" rack cutter, which was illustrated and described in the April, 1905, issue of MACHINERY. The changes which have been introduced include the addition of automatic feeding and automatic indexing mechanisms, and a change in the method of holding the cutters. A countershaft stop has also been added, which throws off the power as soon as the required number of teeth in the work has been cut. The machine has a range of feeds from ½ inch per minute to about 5½ inches per minute, giving a suitable range for either fine or coarse pitch cutters. Since there are 10 inches of cutter space on the spindle, it is well adapted to the use of gang or multiple cutters.

The spindle is driven through a three-step cone at the rear of the top housing. This cone does not appear in either of the photographs. It is mounted on the transverse shaft which shows the farthest to the rear of those whose bearings are seen on either side of the housing. From here the motion is transferred to the right and left-hand spindles at the front of the housing by a train of gearing which can be easily traced in the halftones and the line cut. As may be seen in Figs. 1 and 3, the left-hand, or main spindle, is driven by a herringbone train, while the other is similarly driven by spur gears, the main burden of the driving being imposed on the left-hand train, as will be seen by examining the arbor driving mechanism. The cutter arbor is provided with tongues at either end, which fit in the corresponding grooves in the two cutter spindles. Bolts passing through the cutter spindles enter holes tapped in the end of the arbor. When these bolts are drawn up the two spindles and the arbor form a solid continuous spindle. This construction may be understood by studying Fig. 2 and the two halftones. In removing the arbor the bolts are loosened and the arbor is drawn out toward the front. All of the gears shown are provided with guards which have been removed in taking the photograph in order that the drive may be more easily understood.

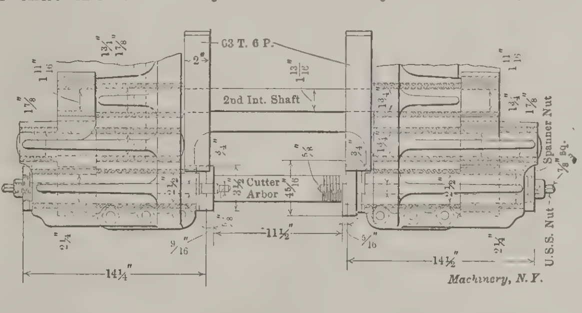


Fig. 2. Spindle Driving Mechanism of the Walcott RackCutter.

As shown in Fig. 3, the feeding mechanism is driven by a pair of four-step cones, of which the driver is connected by a swinging train of gears to a shaft in the spindle driving train. A reach rod whose length is adjustable by means of a turnbolt is provided to keep the belt tight. The push pin shown at the left of the cone in the knee controls a change of feed so that, with the cones, eight different rates are provided in all. Suitable clutches and gearing located within the knee and operated by adjustable dogs provide for a slow forward feed and a quick return after the cutting has been completed. As the forward feed again commences, the work is indexed, thus being automatic in all its actions. The indexing mechanism is driven by a separate quarter turned belt from the countershaft; the driving pulley is shown near the base of the machine in Fig. 1. Two sets of change gears are provid-

ed; the one on the longitudinal feed screw of the table is changed to suit the pitch of the rack being cut, while another set mounted at the front of the mechanism is changed to agree with the number of teeth being cut at one time. If, for instance, four 6-pitch teeth are being cut at one time the gears at the front will be set for four teeth while those on the screw will be set for 6-pitch. The indexing mechanism is operated entirely by positive clutches and gears, there being no friction slip to get out of adjustment and consumed power. For centering a cutter in a tooth space already cut, the index gear on the longitudinal screw is mounted on a friction bearing, which can be tightened by means of the nut shown. With the nut loosened the table may be set at any required point to bring the cutter and tooth studs to the proper position. The gear is then tightened and the indexing proceeds.

A dog at the front of the table operates a lever which trips a chain on the left side of the machine, not plainly shown in the cuts. This chain is connected with the countershaft, as was before mentioned, and stops the machine when any desired position on the rack has been reached by the cutter. The base of the machine is formed to act as an oil tank and is provided with an oil pump. Suitable arrangements are provided for distributing the oil over the cutters and for returning it to the tank. The net weight of the machine is a little over 5,000 pounds.

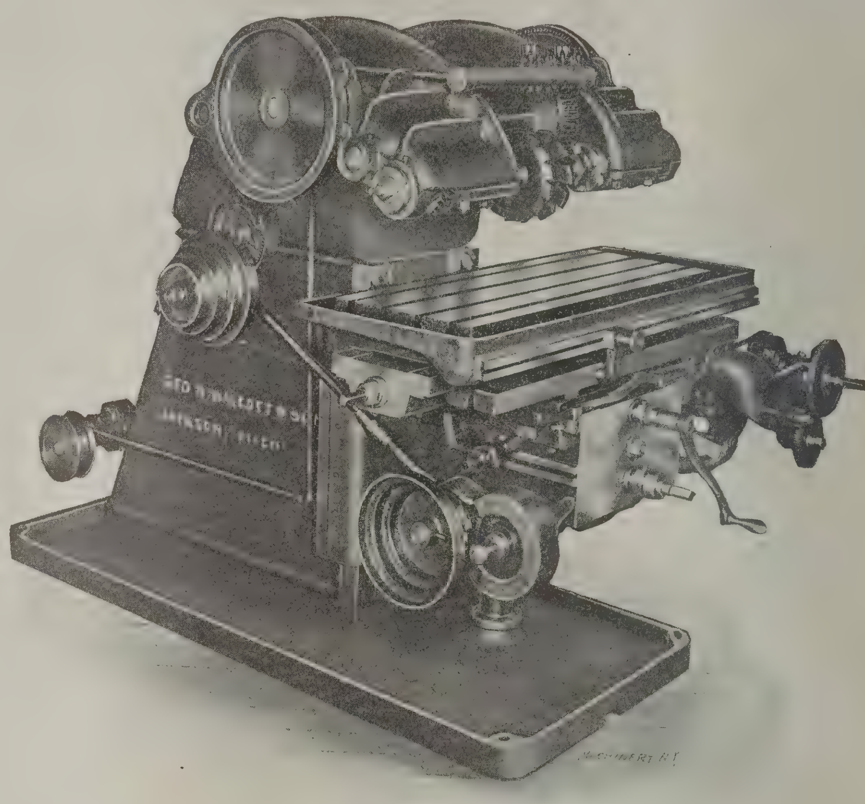


Fig. 3. Left Side View of Walcott Rack Cutter.

* * *

OBITUARY.

Dwight Slate, president of the Dwight Slate Machine Company, Hartford, Conn., died July 31 at his home in that city. He was born May 29, 1816. Mr. Slate was the inventor of the lathe taper attachment and the sensitive drill press and other improvements of machine tools. An extended biographical sketch of Mr. Slate, with portrait, appeared in the July issue.

Daniel B. Wesson, of the well-known firm of revolver manufacturers, Smith & Wesson, died at his home in Springfield, Mass., August 4. Mr. Wesson was born in Worcester, Mass., in 1825. He was closely identified with the early improvement of firearms and is credited with the invention of the metallic case ammunition now universally used in all breechloading small arms, but this is disputed, the invention being claimed by some as that of C. D. Leet of Springfield, Mass. The firm of Smith & Wesson had its inception in 1852 at Norwich, Conn., but the manufacture of revolvers did not begin in Springfield until 1857. The outbreak of the Civil War gave a great impetus to the business and it became very successful.

* * *

PERSONAL.

Frederick Hitchcock, of Meriden, Conn., has been made principal of the Manual Training School of New London, Conn.

Redfield Allen, for the past five years chief draftsman of the engineering department of the Fore River Shipbuilding Co., has resigned.

John W. Pilling, formerly of Waterbury, Conn., has been appointed assistant superintendent of the mill department of the Seymour Mfg. Co., Seymour, Conn.

H. J. Bachmann, a frequent contributor to MACHINERY, has severed his connection with the Mergenthaler Linotype Co. and has accepted a position as superintendent of the Alton Mfg. Co., of New York City.

H. A. Sedgewick, for several years superintendent of Gay & Ward, Inc., Athol, Mass., and later connected with the Union Twist Drill Co., successor of the above firm, has resigned his position to become superintendent of Madison-Kipp Lubricator Co., Madison, Wis.

FRESH FROM THE PRESS.

THE ANALYSIS AND SOFTENING OF BOILER FEED-WATER. By Edmund and Fritz Wehrenfennig. Translated from the German by D. W. Patterson. 290 pages, 6 by 9 inches, and 171 cuts. Published by John Wiley & Sons, New York. Price $4.00.

This book in review is of the second edition, and is, perhaps, the most valuable treatise on the subject of boiler feed water analysis and softening now available in England—thanks to Mr. Patterson, the translator, who had found it invaluable in his work. Of the Wehrenfennigs, the first named is chief inspector of the Austrian Northwestern Railway in Vienna, and the second is an analytical chemist and director of factories in Eggenburg. By chapters the topics are as follows: Impurities in Feed-water; The Analysis of Water; Preparation of the Necessary Chemicals for Water Analysis; The Improvement of Water; Determination of the Amount of Reagents; Testing the Softening; The Removal of Precipitate from the Treated Water; The Accomplishment of Water Purification and the Separate Arrangements Therefor; Review of the Development of Water-purifying Plants; Critical Examination of Water-purifying Plants; Study Concerning the Installation of Water-purifying Plants; Report on Water-softening by the Society of German Railway Managers; Method of Tabulating Data. The book is of special value to railway chemists and others having to do with purification of feed-water for locomotives. This subject is becoming a most important one in railway management, and we shall expect to see a great improvement in present American railway practice in the near future. The book is cordially recommended to all interested.

NEW TRADE LITERATURE.

NATIONAL MCH. TOOL CO., 208 Lawrence Street, Cincinnati, O. Latest pamphlets issued are The Verdict, being made up of letters of commendation of their key-seating tools; and Improved Speed Changers, devoted to description of the new and distinctive features in the design of speed changers.

WHITCOMB-BLAISDELL MCH. TOOL CO., 134 Gold Street, Worcester, Mass. Catalogues of Patent Geared Head Lathes and Whitcomb Planers. The catalogues are arranged with a general description in the front, followed by alternate pages of description and illustration of the various types.

THE AMERICAN LOCOMOTIVE CO., 111 Broadway, New York. Pamphlet reproducing a paper "Large Steam and Electric Locomotives" read before the New York Railroad Club by Mr. J. E. Muhlfeld, general superintendent of motive power of the Baltimore & Ohio Railroad; together with abstracts from transactions by the members. The paper is a discussion of the relative merits of large steam and electric locomotives, comparing the performances of the Mallet type articulated compound No. 2,400, built by the American Locomotive Co. for the Baltimore & Ohio Railroad, and the electric locomotive No. 7-8 built by the General Electric Co. for that road. Mr. Muhlfeld says that the results obtained by the articulated type of locomotive cannot be duplicated by other single units of steam, electric or internal combustion locomotives in use on American railroads to-day.

MANUFACTURERS' NOTES.

THE BATES FORGE CO., Indianapolis, Ind., are making a large addition to their plant that will double their capacity. Most of the new machinery has been contracted for.

THE LINK BELT MACHINERY CO., Chicago, Ill., under its new name, the Link Belt Co., has purchased the plants and all other assets of its associate companies—the Link Belt Engineering Co., Philadelphia, Pa., and the Ewart Mfg. Co., Indianapolis, Ind. It will maintain the offices and operate the plants as now established.

MR. ARTHUR APPLETON has been made resident manager of the New York office, at 45 Broadway, of Pawling & Harnischfeger, Milwaukee, Wis., builders of traveling cranes, and will represent this firm's interests in and about New York City, the New England States and Eastern Canada. Mr. Appleton was formerly associated with William Sellers & Co., Philadelphia, for many years as traveling salesman.

RAILWAY MACHINERY.

A special edition of MACHINERY devoted to Locomotive and Car Equipment and Mechanics.

October, 1906.

ADRIATIC TYPE FOUR-CYLINDER BALANCED COMPOUND LOCOMOTIVE OF THE ITALIAN STATE RAILWAYS.

ITS OBJECTS, CONSTRUCTION, OPERATION AND ECONOMICAL RESULTS.

CHARLES R KING.

The Adriatic or Meridionli Railways of Italy have ceded to the State all their locomotives and plans for new types of machines—the whole of which will henceforth become the standard practice of the Italian State Railways. In the future all the high-powered locomotives of the Italian State Railways will be modeled after the very interesting engine described

Fig. 1. The Adriatic Type Four-cylinder Balanced Compound Locomotive.

in this article. The Adriatic four-cylinder balanced compound locomotive will be perpetuated in all the large machines planned or in construction for various services—express, passenger, fast freight, mountain and ordinary freight, with but slight variations affecting the machine as a whole—*i. e.*, the extensive adoption of single-bearing axles in place of four-wheeled trucks.

The principal feature of these locomotives is the dissymmetric arrangement of the four cylinders, the high-pressure being all to one side, with a single piston-valve, and the low-

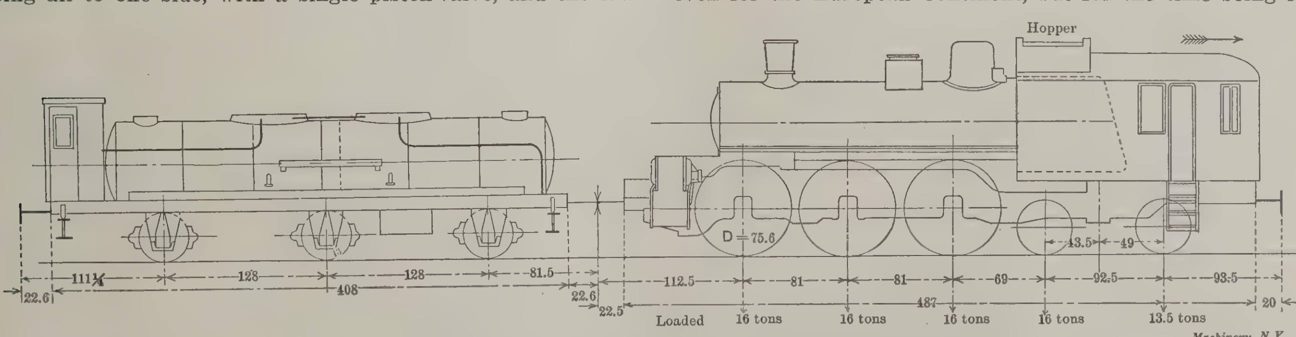


Fig. 2. Diagram of Engine and Water Tank, Adriatic Type Engine.

pressure all to the other side, with a single piston-valve. This arrangement permits any desired difference in the travel or timing of the two valves, and is equal, practically, to many engine designs with four valves and four valve mechanisms. The most evident peculiarity of the present locomotives is the reversal of the boiler on the frames. This was done in order to permit the use of a deep and wide firebox together with six connected wheels. Any other arrangement would have required the firebox to be lifted up over the top of the driving wheels and this, with the restricted constructive gage of Italy, would have been impracticable. An incidental advantage was the placing of the footplate over the pilot truck where the view of the road is as perfect as from the cab of an electric locomotive, and this is, consequently, a great boon to the engineer in sighting signals at all times from any position on the footplate, even when traversing certain curves which with the ordinary arrangement would cause the boiler to block out the view of the road on his side of the engine. With this arrangement any boiler whatever might have a flat-topped firebox completely filling the constructive gage to its utmost limits and entirely blocking out all view over and around it without in the least affecting the engineer's convenience.

From Fig. 2 it will be seen that the engine is quite small even for the European Continent, but for the time being it is impossible to increase the size of the boiler, for the reason that the extreme limit weight per axle has already been reached, *i. e.*, 16 tons. It is, however, a remarkable engine not only for its unprecedented economy but also for its power. Take the engine and tender together with half the full load of fuel and water (99 tons), and compare this with the maximum load which it pulls in a very difficult express accommodation service (called "direct" trains in Italy), which is 490 tons, and we will find that one ton of engine

pulls five tons of train at speeds of up to 54 miles per hour. It is very difficult to find authenticated cases of a similar proportion of 1 to 5. This figure might be touched by single expansion engines by reason of the lighter weight of these latter, but then the fuel consumption will differ widely, and therefore the comparison would not be just.

The engine has one high-pressure and one low-pressure cylinder inside the frame and one high-pressure and one low-pressure outside of the frame. Inside they are slightly in-

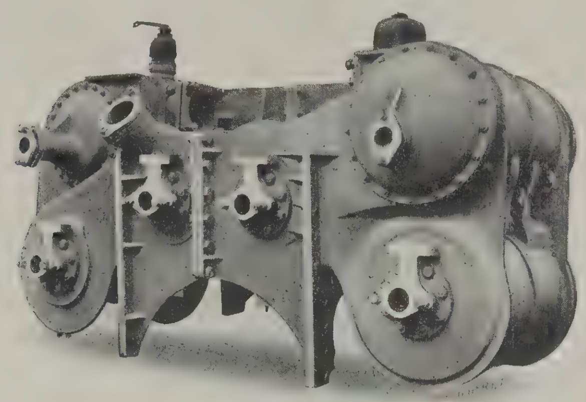


Fig. 3. Cylinders and Valves, Adriatic Type Engine.

clined (7 degrees), outside they are horizontal. The single piston-valve for each group of two cylinders is placed outside in the same vertical axis as the outside cylinder on either side, and both valves have a horizontal alignment. The whole of the cylinders and valves are cast in two pieces bolted together a little out of the center line of the machine, this being in order to give the low-pressure inside cylinder a little more room.

The high-pressure cylinders are connected with the low-pressure cylinders as follows: The receiver, a transversal pipe (*R*, Fig. 4), joins the middle of the high-pressure valve

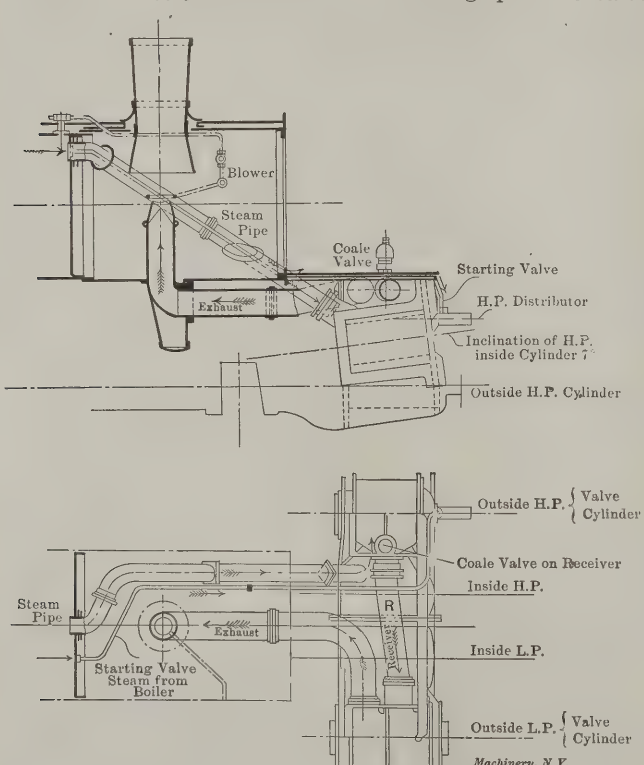


Fig. 4. Diagrams of Cylinders, Adriatic Type Engine.

chest with the back end of the low-pressure valve chest. (In this description the locomotive is always considered as advancing with the firebox in front and the cylinders behind.) This receiver is protected against condensation by means of an enveloping pipe. The connection to the two high-pressure cylinders is by direct steam ports to the inside cylinders, as shown in Fig. 5, and by crossed steam passages to the outside cylinder, as shown in Fig. 6. The opposite end of each cylinder is, it will be seen, in constant communication with that of its fellow, and the pressure operating against their two pistons must, as a consequence, be precisely the same.

For constructional reasons it was desirable to avoid crossed passages on the low-pressure side. Double-ported valves with double type piston-valves are employed, as shown in Fig. 7. The exhaust passes around the body of the valve which it serves to protect against condensation. The spaces *A* are all open to the exhaust to the smokestack. The action of the valve is plainly indicated on the cut. The connection by which the opposite ends of the cylinders are maintained in constant communication with that end of the valve chest from which the fellow cylinder is served, is a small tube fitted outside the cylinder and beneath the clothing. The two tubes are not visible in any of the cuts. Through them the steam pressure at the opposite ends of the cylinders is assured equality at all times.

The cylinders of these engines have a ratio of volume high-pressure and low-pressure of only 1:2.7, or, inversely, the high-pressure cylinder volume is 37 per cent of that of the low-pressure, which is somewhat higher than the 34 and even 33 per cent common in the most recent continental practice (*i. e.*,

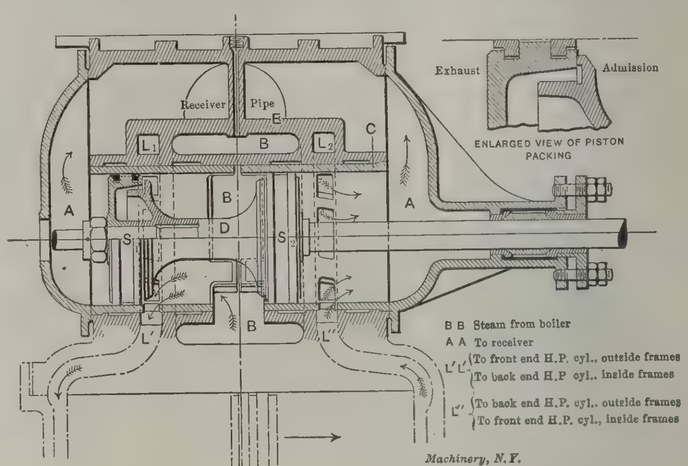


Fig. 5. Section of High-pressure Valve, Adriatic Type Engine.

1:2.9 and 1:3). In the Adriatic engines the working pressure is, however, only 201.3 pounds. As usual where the ratio of cylinder volumes is somewhat low, the low-pressure valve motion is set to give a cut-off 20 per cent larger than the degree of admission allowed by the high-pressure valve motion.

As a general rule, for high speeds the minimum cut-off advisable is fixed at 35 per cent for the high-pressure and corresponding to about 42 per cent for the low-pressure cylinders. For reducing the work of the machine, rather than reducing the valve travel below 35 per cent of piston stroke, it is preferred to operate with the throttle. This refers to the most recent practice. In the earlier engines of his type, before the engineman had been thoroughly broken to compound workings, it was usual to haul the heaviest trains with 15 per cent admission on the level, and from 25 per cent up to 30 per cent admission on heavy grades. Many hundreds of miles on various railway sections were traveled by the writer with the engines working in this manner, disapproved by the traveling inspectors, and yet the locomotives in every case proved remarkably economical and to possess an extraordinary capacity for hauling heavy loads at speed. The medium admission of 20 per cent (+ 24 per cent in the low pressure) corresponded to an expansion at the point of release nearly 21 times the initial volume, and this excessive lamination undoubtedly militated against the best efficiency of the machines. This practice has now been changed. At present, with a train-load behind the tender of 450 metric tons (say 490 U. S. tons) and at full speed, the rule is to work between the extreme limits of 35 per cent and 50 per cent according to the grade. On the level in ascending light grades, 40 per cent is now customary. This, with 48 per cent in the low-pressure valves, corresponds to a total admission for the two cylinders of about one-fifth, or, 40 per cent × 48 per cent

= 19.2 per cent, say, 20 per cent. On heavy gradients the 50 per cent (high pressure) admission equals 50 per cent × 60 per cent (low pressure) = 30 per cent, or an admission of 11-10, and an expansion of 9-10 of the total volume of the two cylinders.

After tentative trials the clearance-volumes allowed in the cylinders have been fixed as follows: 15 per cent for the high pressure and 8 per cent for the low pressure. Both piston valves are 10.4 inches diameter and have a steam lap of high pressure, 1.34 inch; low pressure, 0.9 inch, and a lead to exhaust of high pressure, 0.078 inch, and low pressure, 0.118 inch. Here it should be mentioned that the engines are designed for maximum speeds of 60 miles per hour and for loads of 460 tons in express service, 490 tons in fast freight service and 930 tons for special freight service; in all cases exclusive of the engine's weight. The maximum tractive effort (theoretical) is 7.2 tons and the load under each driving tire 16 tons, or 0.6 tons in excess of the regular limit allowed for the light Italian tracks. Sand has to be used liberally in starting trains.

All the effort of the four cylinders is concentrated on one (the middle) connected axle which is of the Z crank-axle type and hollow. The inside cranks are arranged, as usual, in balanced compounds, at an angle of 90 degrees, the crankpins outside forming an angle of almost 180 degrees with the nearest crank inside. As the inside cylinders (high pressure and low pressure) are inclined 7 degrees in order to allow the pistons to clear the rear axle, this angle is compensated by keying each outside pin so as to precede the two inside cranks by an advance (in the normal direction of running) of 173 degrees, as shown in the diagram, Fig. 8.

As the machine always works compound, means are provided for supplementing the steam in the receiver to enable the low-pressure cylinders to start the train whenever the two high-pressure cranks would be near dead center—a matter of importance with the Adriatic system, as will be seen by a glance at the diagram Fig. 8. It is for this reason that the starting valve has in this machine been made a constituent part of the throttle, and in such a way that a momentary admission of live steam to the receiver always takes place in starting the locomotive. Briefly described, this consists of a small double supplementary throttle valve on the back of the main throttle valve, and which, when the engineer pulls his lever, uncovers a port in the latter through which steam passes into a special conduit in the valve seating which is in direct connection with the receiver. But the continued pull on the handle then raises the main valve and at once interrupts the supplementary admission to the receiver, which cannot take place again until the throttle is once more opened from its fully closed position.

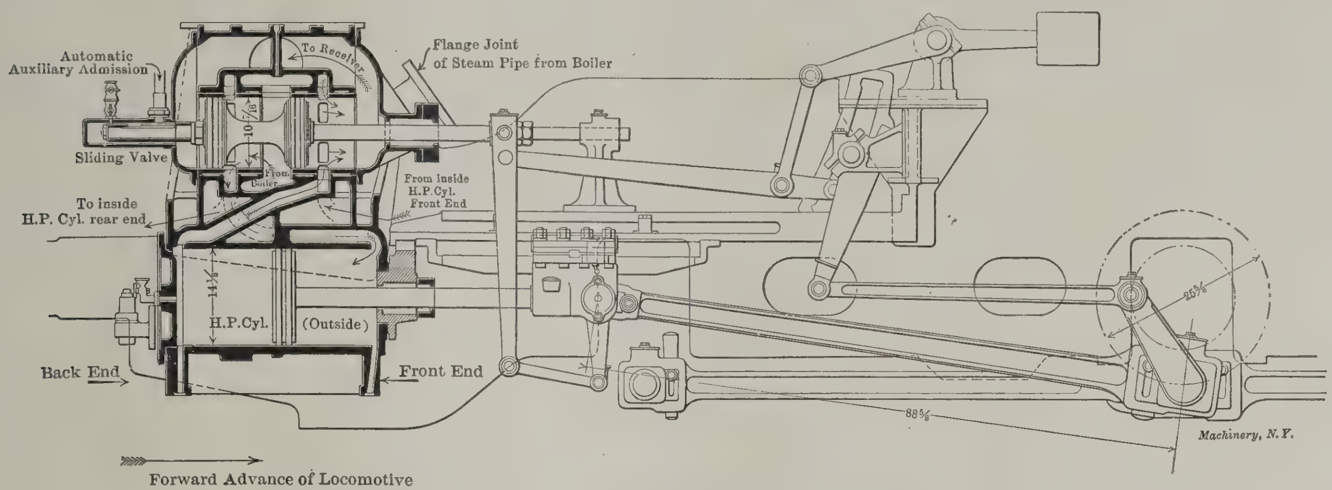


Fig. 6. Section of Outside High-pressure Cylinder and Valve, Adriatic Type Engine.

An interesting addition to these locomotives is the pivoting axle box, shown in Fig. 9. The object of the pivoting liner between the axle box and the frame guides is to permit the axle to oscillate freely about a theoretical longitudinal axis. With ordinary rigid flanges or cheeks to the axle boxes the unequal vertical displacements are absolutely opposed by the parallelism of all the parts effected. The axle seeks to describe a circle, but the frame guides oppose this. The compromise between the two results is diagonal wear on the upper and lower surfaces of the axle box flanges; grooving of the extremities of the journals and their bearings; frequent breakages of the brass bearing flanges, of the horn blocks or axle box guides, and also of the frame plates. The steady augmentation of these troubles is attributable to the greater weight of engines calling for increased dimensions in the length of journals and also in the width between the horn block faces, to the greater thickness of the frames and to the methods employed for increasing the rigidity of the frames, and also to the higher center of gravity now common, accompanied by the higher speeds of running. The usual remedy for these inconveniences has been a resort to greatly increased dimensions, thus abating the frequency of breakage,

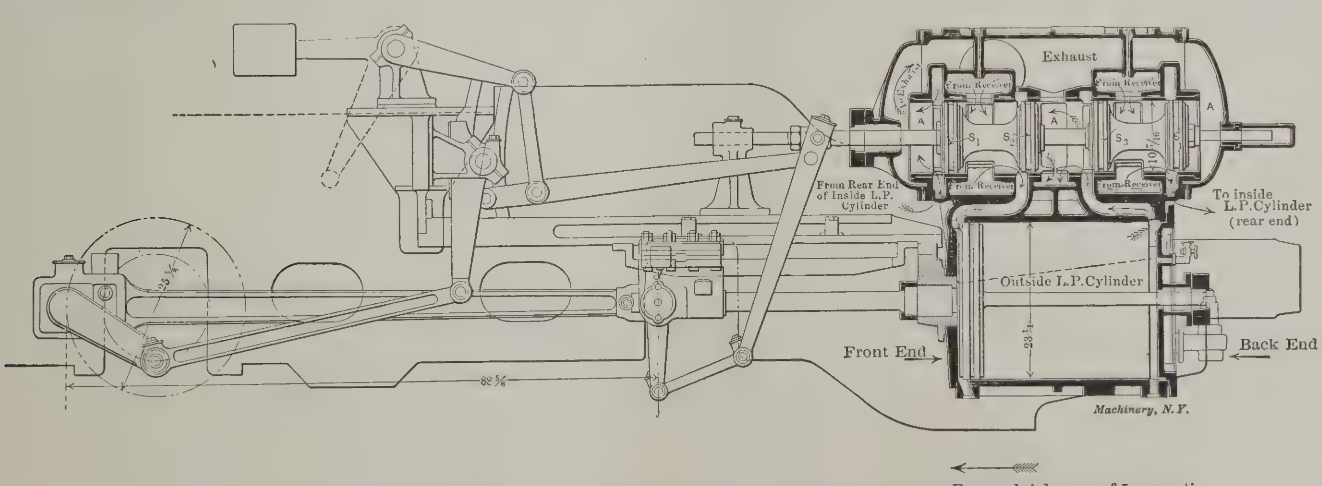


Fig. 7. Section of Outside Low-pressure Cylinder and Valve, Adriatic Type Engine.

but not eliminating it entirely. The obvious practical solution is a hinge, just as we find in side rods. This hinge or pivot is very simply effected by means of liners interposed between the forward and rearward faces of the axle box. These liners are parallel in width, except at mid-length, where there is a flat circular portion which fits into a corresponding flat circular recess in the axle-box face. The recesses in the axle box which correspond to the parallel portion of the liner are fan-shaped, thus allowing the latter free play to revolve within certain limits. The liners carry the flanges embracing the horn blocks or guides, and they merely take the place of

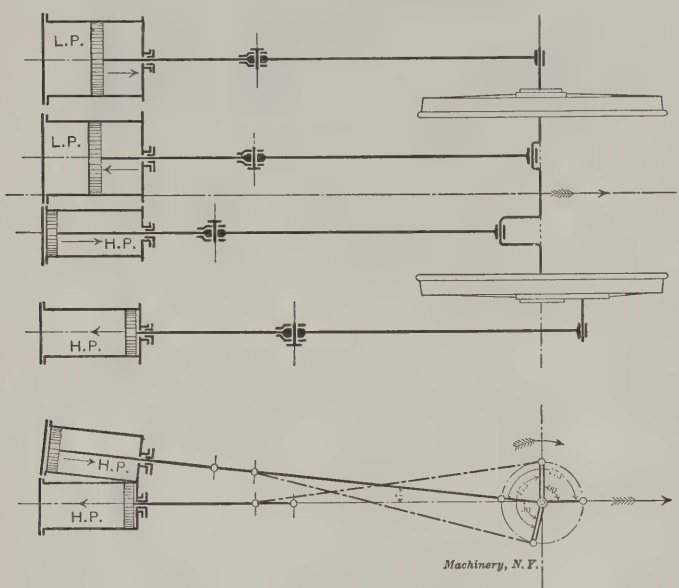


Fig. 8. Diagram of Cylinders and Piston Action, Adriatic Type Engine.

the liners or rubbing blocks that are used on many railways in place of the usual screw wedges for taking up the wear between the axle boxes and their guides. The arrangement eliminates all strain, stress and the wear due to non-parallel movement of the axle even on curves of the shortest radius at fast speed, or on poorly maintained track inducing transverse rolling, while a closer and more regular contact of all parts is maintained through the elimination of wear and the play caused thereby. The shocks upon entering curves are reduced while the speed may be increased rather above the usual limits at such parts of the road, and on the other hand heating of axle boxes is decreased in very many instances. About 2,000 such boxes are now in use.

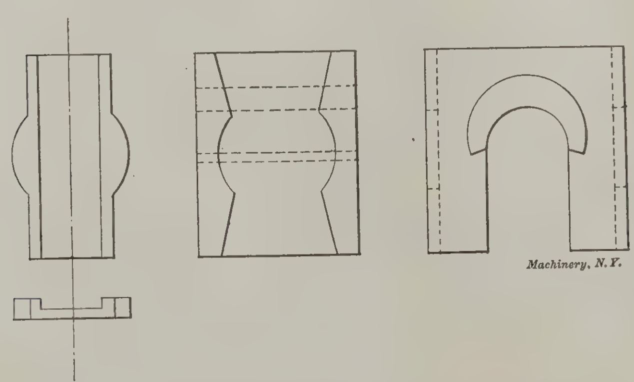


Fig. 9. Pivoting Liner and Axle Box, Adriatic Type Engine.

The boiler construction of this locomotive presents few details that will interest American engineers. Its reversal, end-for-end, introduces no novelty of operation that has not been already common to thousands of suburban locomotives running with the firebox in front. Tank locomotives, 4-6-4, running firebox in front, differ very little in operation from the Italian express locomotives here described. The same ordinary care is required in both with regard to the lowered level of water over the firebox crown in ascending gradients, but this is a matter of habit. Likewise the same attention is required to avoid cold air currents on the flue sheet either from a thin fire immediately against it, or from a prolonged opening of the firebox. These locomotives are provided with fire-hole deflectors directing the air current downwards below the brick arch, and the introduction of air on top of the fire by means of slightly opening the door is recommended for a few minutes' interval after firing, in order to consume the smoke. This is only allowable with a fairly well filled grate. The grate is flat and the coal is laid on in the form of a saucer, tilting slightly downward beneath the brick arch.

With these ordinary precautions the reversed boiler for express service has proved itself to be much superior as a generator to the normal type of locomotive boiler working on the same roads. The coal bunker of three tons' capacity is situated on the right-hand side, advancing. It occupies the space above that same side of the boiler in order to concentrate the weight at the center line or axis, and most of the space on that side of the cab is also occupied by the descending fuel. There is also a small bunker for one ton of briquettes under the front windows, also on the same side of the cab. Had the limit to the wheel loads been of as little importance, as in America, the entire bunker could have been located beneath the forward windows, just as is usual with tank locomotives.

Non-conducting substances, asbestos, etc., are not often used in Continental practice beneath the boiler clothing, but asbestos is employed here, around the firebox only, to prevent radiation of heat. The cylinder water tank is always coupled behind the locomotive, which normally runs cab first. But to enable the engine to run chimney first in local work, switching, etc., and at speeds not exceeding 40 miles per hour, the injector feed pipes from the tender are carried the whole length of the engine, one pair on either side, and each pair in connection with flexible couplings both at the back and at the front end of the locomotive. In switching the engine is uncoupled from its tender, and in coupling up again either end of the engine may become the front end.

The injectors in connection with the feed pipes are located beneath the cab. In the cab the arrangements are as follows: In the front left hand corner grouped about the engineer's seat: Horizontal reversing wheel; vertical scale of the expansion-gear fixed on front wall of cab; throttle lever over reversing wheel for engineer's left hand grasp; whistle-pull, next to throttle lever; under engineer's left hand, forward of the reversing wheel, two triple valves operating Westinghouse brakes on all the wheels of engine and tender. As there are two separate air reservoirs for the two brake cylinders, one for the driving wheels and one for the truck, there are cut-off cocks placed in the connecting pipes so that either set may be worked independently. The brake cylinders are both shown in Fig. 10. In addition there is a hand brake (fireman's) on the six connected wheels. On the bracket carrying the vertical reversing screw is placed the handle which operates the compressed-air sander, and the same bracket carries the sliding shield which cuts off the rays of light from the open firebox at night time. The lever operating the purge-cocks of the cylinders is placed conveniently near; the regular purging of four cylinder compounds with piston valves is of first importance. Previously this operation would sometimes be interrupted by careful engineers in order to avoid scalding linemen, therefore the purge cocks now discharge into perforated mufflers, and save enginemen any concern in this score. To reduce the amount of condensation which occurs after the engine has been standing long in the stations, and which during the very severe cold of the Italian winter is necessarily considerable, the engineer simply sets his throttle over the starting valve port, thus passing steam for heating direct to the receiver and low pressure valves. The engineer can feel, by touch of the lever, the place of his throttle over the opening. This warming up and subsequent purging might be made automatic by suitable connections with the throttle and reversing screw, but it has not, so far, been done with the engines of this class.

The boilers steam best with water maintained at medium level, whether on the level or in mounting steep grades when, of course, the level falls rather rapidly aided by the upward inclination of the firebox. A very considerable control of the fire is exercised by means of the variable blast nozzle of double wing pattern, but in these engines its influence may

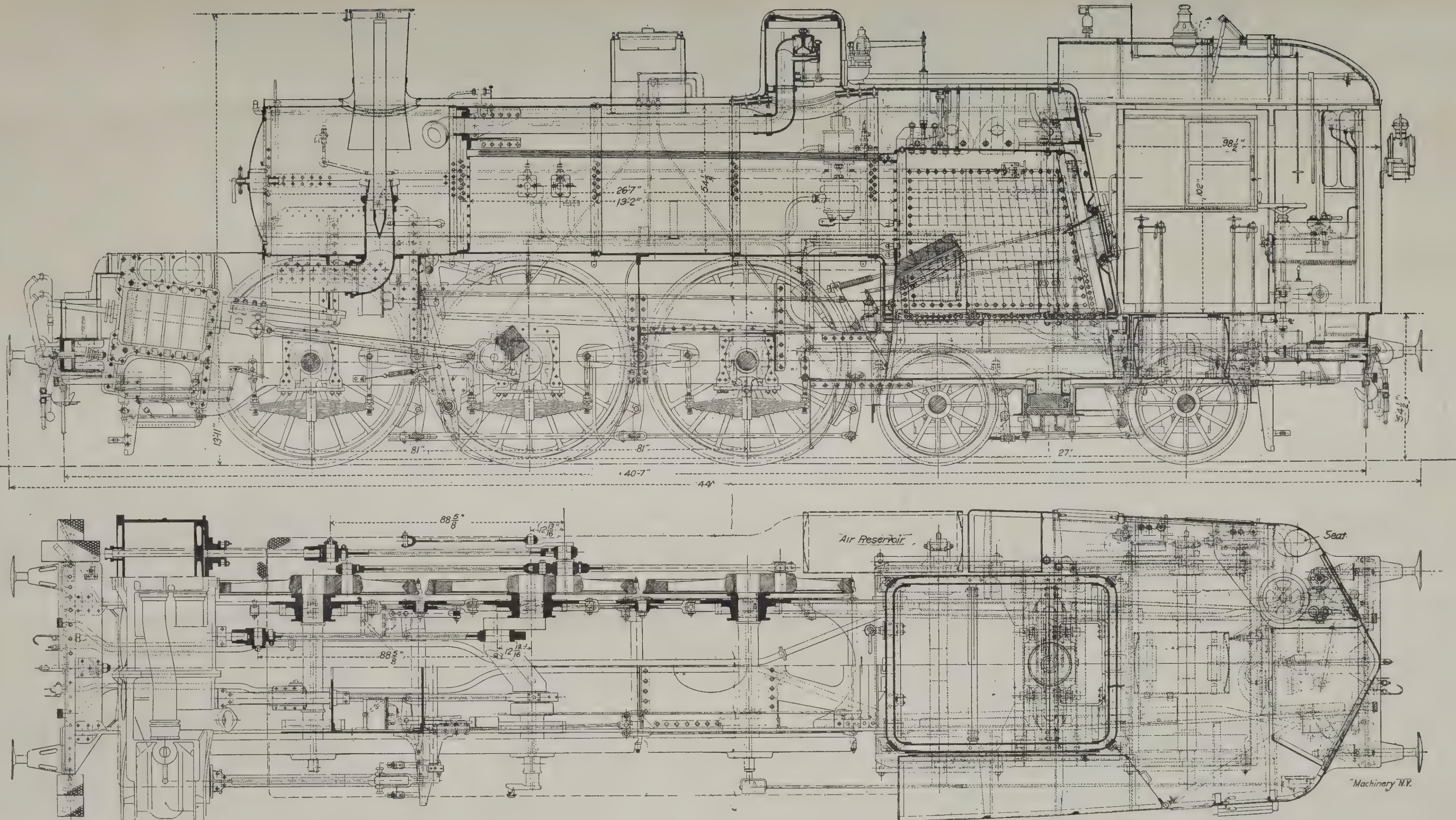


Fig. 10. Plan and Elevation of Adriatic Type Engine.

be very detrimental, hence the enginemen are advised only to decrease the area of the nozzle when all other means fail. The blower is recommended in preference to increasing back pressure on the low-pressure pistons. When running with closed throttle the reversing gear is always set full forward. The engine has no apparatus for running against reversed steam, as is now rather common with such machines, and therefore reversing the engines against steam is only allowed for brief intervals, and in case of break failure. The engine, like all Italian express engines, is fitted with the Hausshaeltor speed indicator and recorder, the dial of which is at all times plainly visible to the engineer. There are at present about 43 of these machines built or in construction. Of the newest types it is not, so far, possible to give details of coal consumption, which will, very possibly, have been reduced to a yet lower figure. Already the coal consumption with the earlier machines of this type has been remarkably low, lower in fact than any which can be traced relating to the averages of other engines for an equally long period of service. In a period of three months' rather light service, not conducive to coal economy in compounds, seventeen engines ran 184,390

miles on a consumption, including lighting up and standing about, of 42.2 pounds per mile or of 40.4 pounds per hour actually consumed in working and while pulling an average net load of only 266 tons as compared with the 400 tons, which is the most economical load for these machines. Reducing the real miles to virtual miles (grade and curve duly computed), this consumption amounted to 144.2 pounds for each thousand ton-miles (the ton weight being that of the useful load hauled by the locomotive and which varies from 170 to 420 tons), and calculations based upon these averages, and according to the various formulas of Barbier, Van Borries and Aspenall, show the consumption to be 2.92 pounds per H. P. hour at the driving wheels, and 2.67 pounds per indicated H. P. hour. Expressed thus merely in pounds of coal, the result may be without value unless the more important factor of coal value is given, consequently, the consumption accurately expressed was 21,000 B. T. U. per I. H. P. hour. The coal (Curdiff) has a thermal value averaging 7,900 B. T. U. per pound. In ordinary boilers it produced up to 7

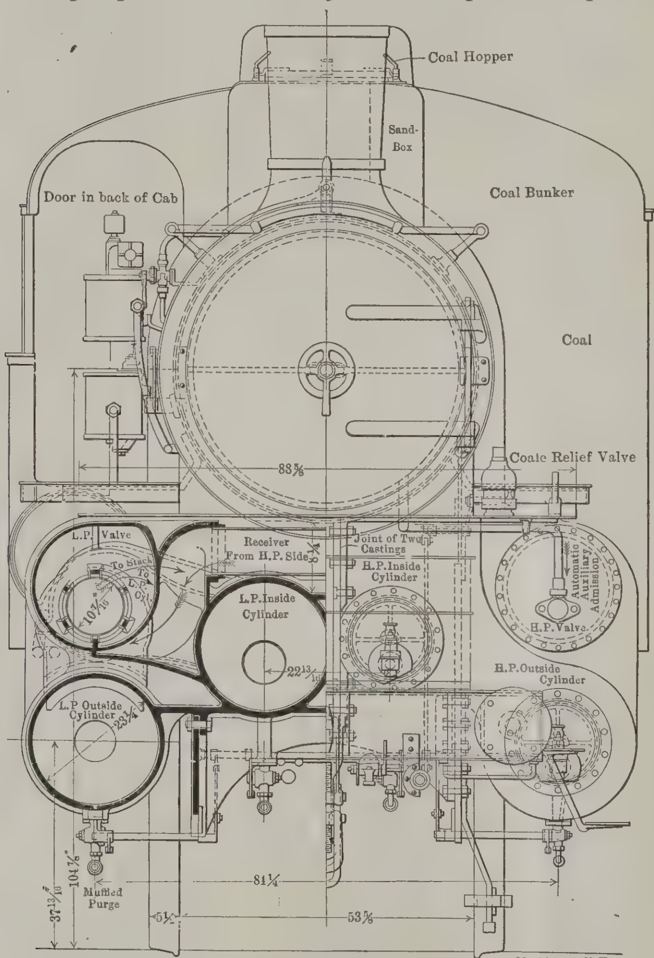


Fig 11. End View, and Section through Low-pressure Cylinders Adriatic Type Engine.

pounds of steam and in the reverse boilers up to 9 pounds of steam per pound of fuel. In the foregoing only the figures relating to a long period of regular service are given. In individual runs in the course of daily work (and not to be cited by the side of special trials where selected coal and all other conditions are arranged to favor the utmost efficiency) the writer has noticed a consumption of 45 pounds per real mile with a train behind tender varying from 400 to 413 tons, or 115 pounds per thousand virtual ton miles, a result 20 per cent more economical than those previously cited and upon which the horse-power fuel consumption is based. Under favorable conditions one H. P. hour, indicated, for 2.35 pounds (18,560 B. T. U.) is probably often realized in the older and less perfect locomotives of the type described. It is true 2.11 pounds was realized with a Woolf-Mallet tandem compound (No. 101) on the South Eastern Railways of Russia in May, 1892, but then that was during special trials.

PRINCIPAL DIMENSIONS.

High-pressure cylinders, diameter	14¼ in.
Low-pressure cylinders, diameter	23¼ in.
Piston stroke	25½ in.
Wheels (drivers), diameter	6 ft. 3⅝ in.
Boiler pressure (working)	201 lbs.
Heating surface (inside), firebox	120.8 sq. ft.
Heating surface (inside), tubes	2149.5 sq. ft.
Heating surface (inside), total	2270.3 sq. ft.
Grate area	32.25 sq. ft.
Weight under driving wheels (loaded)	48 tons
Total weight (loaded)	77.5 tons
Total weight (empty)	67.5 tons
Bunker capacity on locomotive	4.4 tons
Tender weight (empty)	17.5 tons
Water capacity	22 tons
Tender weight (loaded)	39.5 tons
Engine and tender weight (loaded)	117 tons

* * *

THE WALSCHAERTS VS. THE SPEPHENSON VALVE GEAR.

The paper, "The Walschaerts Valve Gear as Applied to Locomotives," read by Mr. James Kennedy before the September 21 meeting of the New York Railroad Club was productive of an interesting discussion. The mechanical engineers of this country's railways are apparently by no means ready to give up the Stephenson valve gear in favor of the Walschaerts, although it has certain conceded advantages. These are lightness, absence of large eccentrics, better frame bracings and, principally, accessibility, the whole gear being located outside of the driving wheels. Some of the speakers deplored the attacks on the Stephenson gear in the paper; they pointed out that it had done yeoman service for American transportation and is still capable of handling a large part of our transportation work; no doubt it will continue to do so for a long time, notwithstanding the present agitation in favor of the Walschaerts gear.

Mr. A. W. Gibbs submitted a written discussion which was enthusiastically in favor of the Walschaerts gear. Its introduction on the Pennsylvania R. R. dates from the importation of the DeGlehn balanced compound, imported from France and exhibited at the Louisiana Purchase Exposition. The Pennsylvania R. R. now has over 400 locomotives built or in process of construction with a Walschaerts gear, and the general sentiment of both the mechanical engineering department and the engine runners is very much in favor of the new gear. This last speaks volumes, for the natural conservatism of locomotive runners is well-known, and unless the new gear is as good or better than the old form they would be likely to condemn it, being unfamiliar with it. So far as steam distribution is concerned Mr. Gibbs stated that it has no advantage over the Stephenson gear and that all its advantages are purely mechanical, being principally those of accessibility and avoidance of large eccentrics between the wheels.

Mr. Angus Sinclair referred to the fact that the Pennsylvania R. R. a number of years ago built a locomotive with the Joy gear, and he asked the question of Mr. Gibbs why it was that this gear had not been developed, in this country, believing as he did, that it has proven to be a very serviceable gear in Great Britain, and is even simpler than the Walschaerts. Mr. Gibbs replied that his experience with this valve gear was quite unfortunate. It was found that the vertical deflection of the connecting-rod when running at high speeds seriously distorted the action, the excess movement of link block being very pronounced, and the wear of the link and block was excessive. Again when rounding curves the irregular action of the gear was serious on account of one side of the locomotive being elevated more than the other relative to the wheels. This action is not particularly noticeable with the English type of locomotive, having, as a rule, inside cylinders which throw the valve gear near the center line of the engine; this reduces the distortion due to rounding curves and swaying generally.

The amount of lead allowed by the Pennsylvania R. R. so far on the Walschaerts type is approximately 5/16 inch, and this, of course, is constant in all positions of cut-off. This feature of constant lead was attacked by Mr. Quereau, who declared that it is a most serious matter for a locomotive which has to haul heavy trains at slow speeds at one time and run at high rates of speed at another to be deprived of the advantages of variable lead. It is obvious that at slow speeds constant lead means pre-admission of steam to the

cylinder, and consequent high back-pressure. With the Stephenson gear the valves may be set so that there is no lead or even a negative lead in long cut-offs, and in the shorter cut-offs, used in running at higher speeds, ample lead is provided for the necessary cushioning effect. Not so with the Walschaerts gear; the lead must be selected for the average speed and any variation above or below is not as well taken care of as with the Stephenson gear. Another drawback to the use of the Walschaerts gear at the present time is the matter of cost; it was alleged by Mr. Quereau that the builders demand about $1,000 more for this gear than for the regular equipment.

Total weight, engine and tender..	503,000 pounds.
Cylinder diameters	21½ and 33 inches.
Piston stroke	32 inches.
Steam pressure	200 pounds.
Driving wheels, diameter	55 inches.

Wheel base of each driver section, 10 feet; total wheel base of engine, 44 feet 10 inches; engine and tender, 73 feet 2¼ inches.

Tubes, number, 441; diameter, 2¼ inches; length, 21 feet.

Heating surface, firebox, 225 square feet; tubes, 5,433 square feet; total, 5,658 square feet; grate area, 78 square feet.

Tractive power, 71,600 pounds.

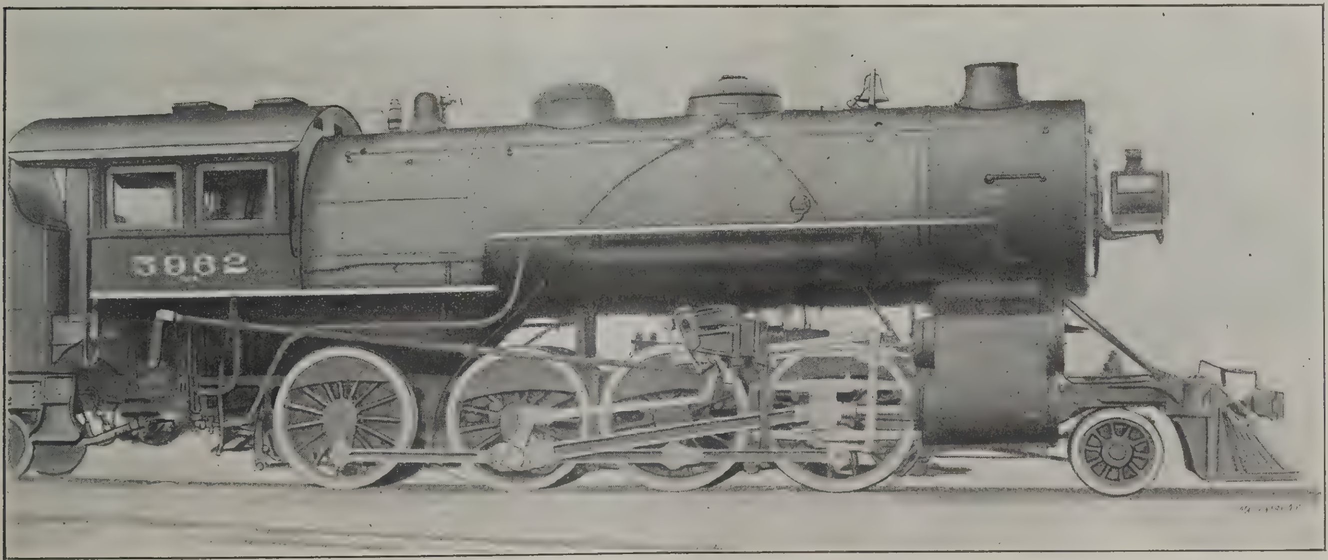
The engines are designed to pass a 10-degree curve.

Great Northern Railway Mallet Compound Locomotive.

GREAT NORTHERN RAILWAY MALLET COMPOUND LOCOMOTIVE.

The Mallet 12-driver articulated compound locomotive shown in the accompanying cut is one of five recently built by the Baldwin Locomotive Works for the Great Northern Railway. It differs from the Baltimore & Ohio articulated compound locomotive described in RAILWAY MACHINERY, July, 1904, in that two-wheel leading and trailing trucks are provided, thus the weight is not carried entirely on the drivers, 41,000 pounds being distributed on the trucks. Its nomenclature by the Whyte system in 2—6—6—2. Balanced slide valves are used on both the high- and low-pressure cylinders; the valve gear is the Walschaerts. The tender carries 13 tons coal and 8,000 gallons water. Following are some of the principal dimensions:

Weight on drivers...............	316,000 pounds.
Weight on front truck...........	19,000 pounds.
Weight on trailing truck.........	22,000 pounds.
Total weight	357,000 pounds.



New York Central Lines Consolidation Locomotive.

NEW YORK CENTRAL LINES CONSOLIDATION LOCOMOTIVE.

The accompanying half-tone shows one of twenty-five consolidation locomotives recently built by the Brooks Works of the American Locomotive Co. for the New York Central Lines. Its design is substantially the same as that of the previous locomotives of this type built for the New York Central, Lake Shore & Michigan Southern, Big Four, and Indiana Harbor lines. The total weight of the engine, however, is somewhat greater than those previously built, due to slight changes in the construction, such as the use of cast-steel bumpers, etc. The design is of interest inasmuch as it illustrates what is now practically the standard 2—8—0 class adopted by the New York Central lines and represents a very large number of locomotives. This order was equipped with the latest type of Walschaerts valve gear, which embodies some improvements, being the result of recent experiences with this gear as applied to large locomotives. The following are the principal dimensions, etc.:

General Specifications, New York Central Lines Consolidation Locomotive 2–8–0.

Cylinder: Type, simple piston valve; diameter, 23 inches; stroke, 32 inches; piston rod diameter, 4 inches; piston packing, Dunbar; valves; type, piston; diameter, 14 inches; travel, 5½ inches; steam lap, 1⅛ inch; clearance, 0 inches; setting, 17-64 inch lead.

Gage, 4 feet 8½ inches, wheel base, driving 17 feet 6 inches; rigid, 17 feet 6 inches; total, 26 feet 5 inches; total engine and tender, 60 feet 9½ inches.

Weight in working order, 232,500 pounds; on drivers, 207,000 pounds; engine and tender, 382,100 pounds; tractive power, 45,677 pounds.

Axles, driving journals, main 10 x 12 inches; others, 9½ x 12 inches; engine truck journals, diameter 6 inches, length 12 inches; tender truck journals, diameter 5½ inches, length 10 inches.

Boxes, driving, cast steel; others, cast steel.

Boiler, type, radial-stayed straight top; outside diameter first ring, 81⅝ inches; working pressure, 200 pounds; fuel, bituminous coal.

Heating surface, tubes, 3,492.18 square feet; firebox, 185.64 square feet; arch tubes, 27.41 square feet; total, 3,705.23 square feet.

Firebox, type, wide; length, 108⅛ inches; width, 75¼ inches.

Grate area, 56.5 square feet; style grate, rocking.

Thickness of crown, ⅜ inch; tube sheets, ½ inch; sides, ⅜ inch; back, ⅜ inch.

Water space, front, 4½ inches; sides, 4½ inches; back, 4½ inches.

Crown staying, radial 1⅛ inch.

Tubes, material, steel to New York Central specifications; number, 446; diameter, 2 inches; length, 15 feet ½ inch; gage, 11 B. W. G.

Exhaust pipe, single.

Smokestack, diameter, 20 inches; top above rail 14 feet 9½ inches.

Brake, driver, Westinghouse-American; tender, Westinghouse; air signal, Westinghouse; air pump, 11-inch Westinghouse; reservoir, 18½ x 120 inches.

Tender, frame, 13-inch channel steel; style, water bottom; capacity, 7,500 gallons; fuel capacity, 12 tons.

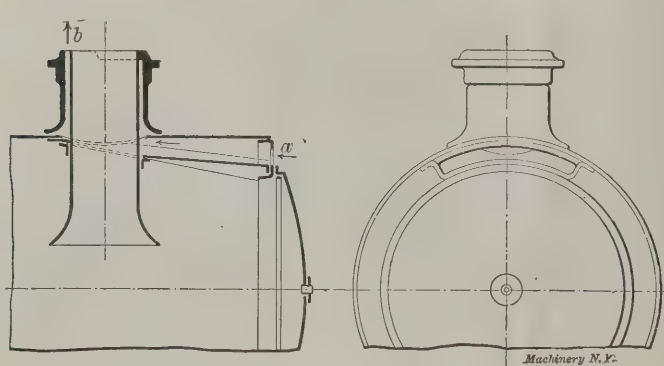
Wheels, driving, diameter outside tire, 63 inches; wheel center diameter, 56 inches; material, cast steel; engine truck diameter, 33 inches; kind, National No. 3; tender brake wheels, diameter, 33 inches; kind Paige plate steel tired.

Engine truck, two-wheeled three-point suspension.

* * *

LOCOMOTIVE EXHAUST DEFLECTOR.

The accompanying cut shows the principle of a new invention, the object of which is to prevent smoke and steam from the chimney of a locomotive settling on the cab windows,

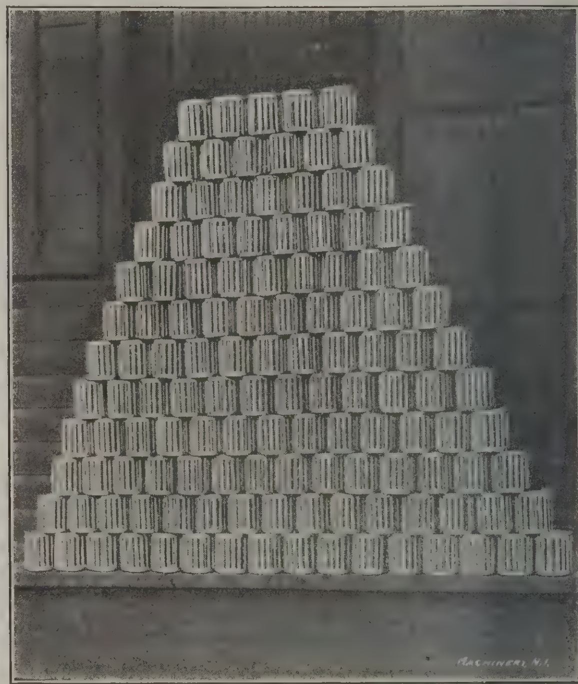


Locomotive Exhaust Deflector.

thus obstructing the view of the engineer. An opening is provided at *a* through which the air will be pressed in with great force when the locomotive is in motion; the air passes around the chimney and up at the rear side at *b* where it will force the smoke and steam upward. According to the *Railroad Gazette*, from which the cut is taken, the device has been applied to locomotives on the Great Northern Railway of England.

CAR AXLE ROLLER BEARINGS.

The accompanying photograph shows a pile of 126 railway roller bearings for 3½ x 5-inch car axles. These were made by the Bantam Anti-Friction Co., Bantam, Conn., and are mostly used upon plantation and industrial railways, especially in Cuba and the South. The present status of railway bearings for car axles is in a rather unsatisfactory condition,



Car Axle Roller Bearings.

as the design of the M. C. B. car box, truck, pedestal jaws, etc., forbid the use of any practicable type of roller axle bearings. Until something can be done to modify the present standard designs the use of roller bearings for railway cars will probably in general be limited to use on private equipment.

* * *

The growth of the use of the Pullman sleeping car is one of those developments which scarcely could have been predicted by any one who was in a position, say forty years ago, to know something of the probable improvement in railroad transportation. In the early days the sleeping car was regarded as a pure luxury to be patronized only by the very wealthy or the recklessly improvident. Now the use of the Pullman sleeping car by the business man is a matter of economy, inasmuch as it is a great saver of time. It enables him to travel say 400 or 500 miles in a night and arrive at his destination in fairly good shape for a day's business. The following night he can return to his home and take up his duties with the interruption of only one business day and without the tiresome monotony of riding in day coaches and practically wasting two or three days extra time, besides the expense of hotel bills. This, of course, is telling what is already well known to every one conversant with common business practice, but it is a very good example of the surprising changes wrought by what are at first regarded as luxuries, and which become business necessities. In other words many of the luxuries of one generation become the necessities of the next.

* * *

According to an article in a recent issue of the *Railroad Gazette*, the Pennsylvania Railroad was probably the last American railroad to adopt the Stephenson link motion. This slowness to adopt an improved valve motion is attributed to the well-known opposition of M. W. Baldwin, who was not favorable to this form of valve gear. Consequently the Pennsylvania Railroad experimented with a great many varieties of gears, fifteen of which are illustrated and described and none of which at all compare with the Stephenson gear in simplicity and effectiveness.

A SOUTHERN MACHINE REPAIR SHOP.

A country machine repair shop is generally of interest to the mechanic; it is a place where ingenuity, enterprise and resource are commonly developed to an extent seldom met with in much more pretentious manufacturing shops. The work that comes to it is generally of an emergency nature requiring instant decision and quick action. Its motto is, or should be, "get there, and do it quick." Instructions from owners are usually indefinite and vague, their principal consideration being limiting the cost and the time. Usually there is no precedent, but if the work is not satisfactory there will always be a hereafter. An engine, for example, must be made to run a few weeks longer; it needs a thorough overhauling, or what is more likely, relegation to the scrap heap, but the proprietor can spare neither the time nor money at the present for thorough repair or replacement. The present machine must be made to run somehow, and that somehow is up to the repair man. Long hours and undesirable work are the rule, but the work nevertheless has its compensations to those who love it.

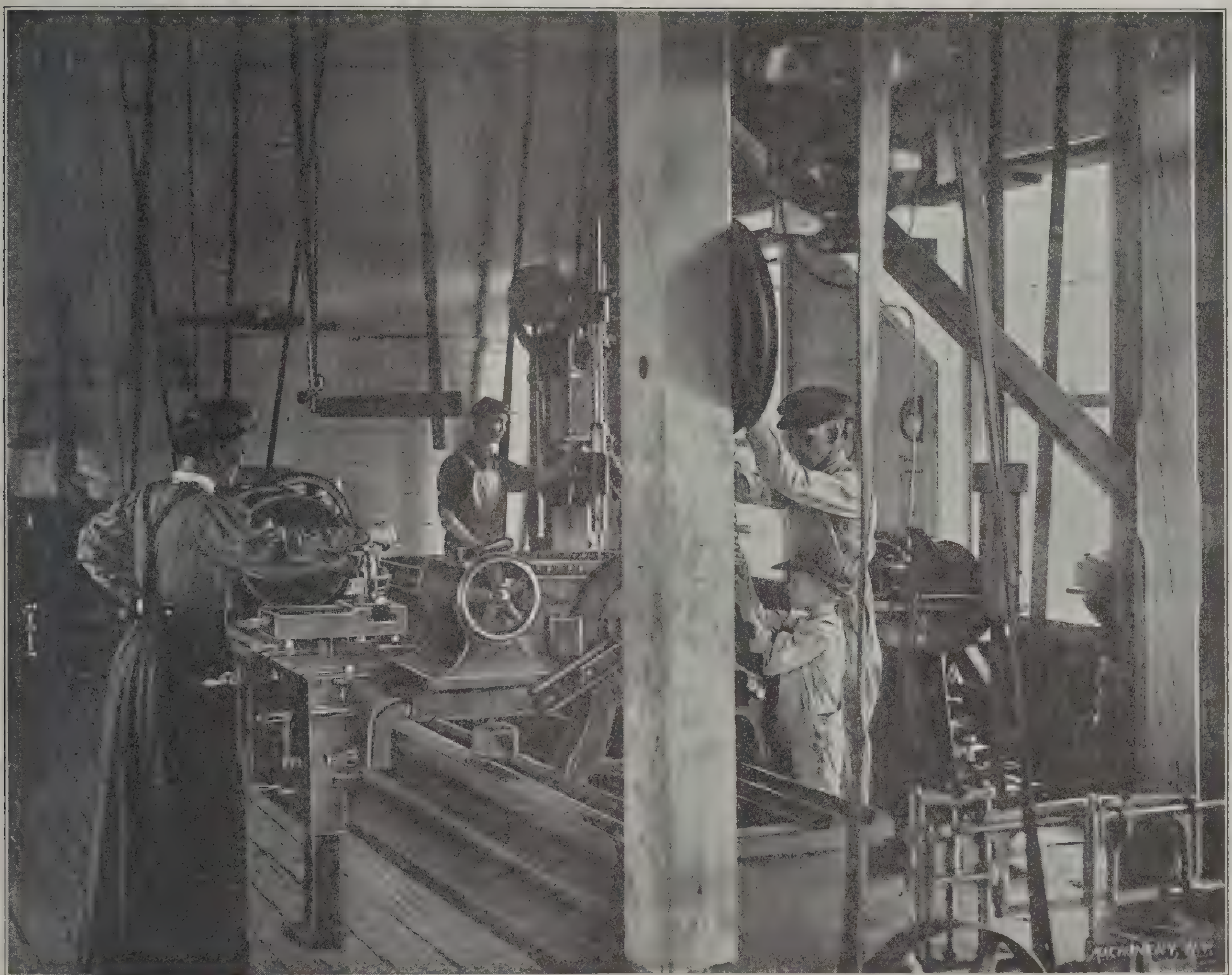


Fig. 1. A Southern Machine Shop; All Hands at Work; Mrs. Parkins Turning a Piston Rod

Down South in Dickey, Ga., is one of these repair shops, typical in meeting all the demands of the country round about, having the reputation for first-class work and unique in having for one of its principal all-around mechanics a woman of resource and mechanical ability equal to almost any emergency. The shop is that of Mr. Eugene P. Parkins, and his wife is his principal helper. Mr. Parkins was born in Champaign, Ill., forty years ago; his father moved to Atlanta, Ga., when he was but a lad. In 1879 his father bought a plantation in the southwestern part of the State, and moved there with his family. Among other improvements which he made was the installation of a cotton gin, driven by a small engine and boiler. In 1883 the son left the farm, for he was never satisfied there except when the engine and boiler were in operation. He entered the repair shops of the Western & Atlantic R. R. as an apprentice and stayed there five years. Then with his savings he equipped his first machine shop, which was built back on the old home farm, adjoining the gin house. The boiler and engine which used to run the gin furnished the power to run the shop. The first tool equipment consisted of of a 16-inch by 8-foot bed Perkins lathe, and a 10-inch crank shaper, a small drill press, a grindstone, together with such small tools as he could afford to buy, including stocks and dies for threading pipe, screw plate, taps and dies, etc.

The building of a shop in the heart of the "piney woods" fourteen miles from a railroad was "a seven-day wonder" and everyone, without exception, predicted failure, but the proprietor was not ambitious beyond what he could clearly see, and he saw the chance to build up a good business with perseverance and first-class work. This has always been his hobby—the turning out of first-class work. When the shop was first built the people in this section of the country had to send their work to Macon, over 100 miles distant, or to Montgomery, equally as far. Hence the shop was a great boon to the locality. There were innumerable cotton gins and saw mills in the locality and the owners of these soon learned the road "to Parkins."

As time passed Mr. Parkins saw the need of more tools and larger machinery, which were added from time to time as his business warranted the expenditure. The shop really built and equipped itself from the very start, all the machinery having been purchased from the earnings. In 1891 Mr. Parkins married a young lady in Washington, D. C., who at that time was stenographer, typewriter, bookkeeper, etc., to one of the prominent business men of that city, a man who afterward was one of the commissioners of the District of Columbia. Soon after his marriage, Mr. Parkins built a new

and larger shop and his dwelling house was attached. In fact, the shop and home are under one roof. This proved to be a most satisfactory arrangement, because Mrs. Parkins now spends a large part of her time in the shop as a general all-around helper to her husband. At first she would take her sewing to the shop for "company's sake." Then, having a natural taste for the intricacies of machinery, she became interested in the work and would often take hold and do some simple job. Now she is a full-fledged machinist and carries on the work in her husband's absence. In fact, last summer she ran the shop every day for three months, doing all the work as it was brought, with the assistance of an apprentice and her son, and she has never had to turn away a piece of work yet because she did not know how to do it. The general class of work which comes to the shop is principally engine repairs. The work in which she particularly excels is the reboring of cylinders, making new pistons complete, including head rod and rings, planing and fitting rod brasses, planing valve seats, repairing injectors, etc. Many of these jobs are done from start to finish without any assistance whatever from Mr. Parkins, and, in fact, many of them he never sees from the time they come into the shop until they

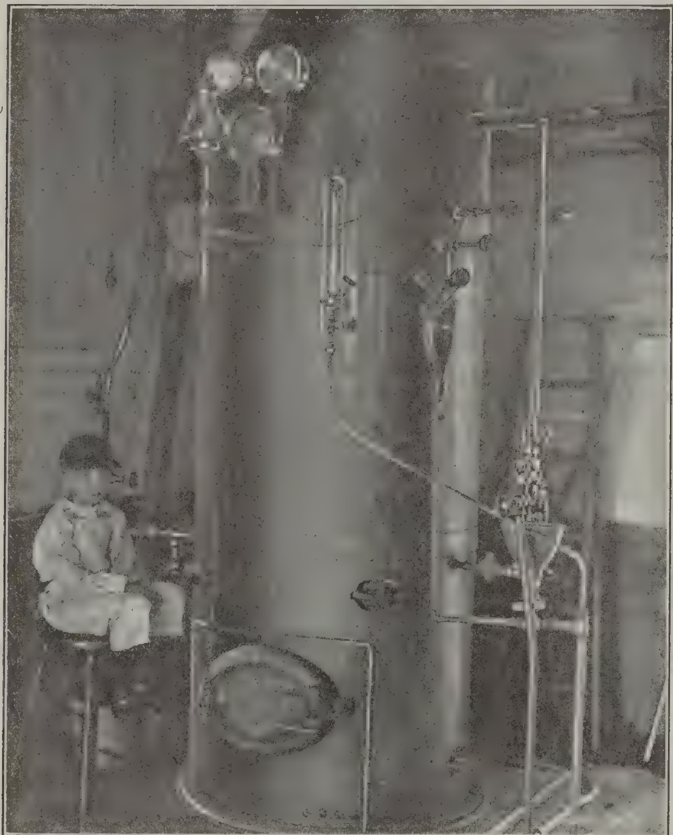


Fig. 2. The Boiler and the "Fireman."

leave, ready for business. The normal shop force consists of Mr. and Mrs. Parkins, a 16-year-old apprentice, and her seven-year-old son, who is the fireman.

After Mr. Parkins had been in business a year or two he found that he must learn boilermaking as an extra trade, for he was frequently called upon to repair boilers as well as engines. At first he would send to Macon for a regular boilermaker to do the work, but by watching the work and helping under directions he soon "caught on" to the principles involved, and then it was only experience and practice that were required. To-day he is a competent boilermaker, able to do all the repair work of this kind that comes his way. He keeps in stock boiler steel for patches, patch bolts, all sizes of rivets, and all boiler tools, such as flue expanders, staybolt taps, patch-bolt taps, and, in fact, any tool or chisel necessary for turning out a first-class job.

The present equipment of the shop consists of a Hamilton lathe, 26-inch swing by 16-foot bed, with quick-change gear screw cutting attachment; the small Perkins lathe before mentioned, which "built the shop"; a 32-inch Steptoe gear shaper; a 30-inch drill press, with power feed; emery grinder with two wheels, wet and dry; and a power hack-saw. Besides, there is a splendid equipment of all small tools necessary to turn out strictly first-class work, such as drills, reamers, taps, screw-plates, files, chisels, dies for threading pipe up to 3 inches, the larger threads being cut in the lathe. All lathe and shop tools are of the inserted cutter type, the old forged type having been discarded long ago.

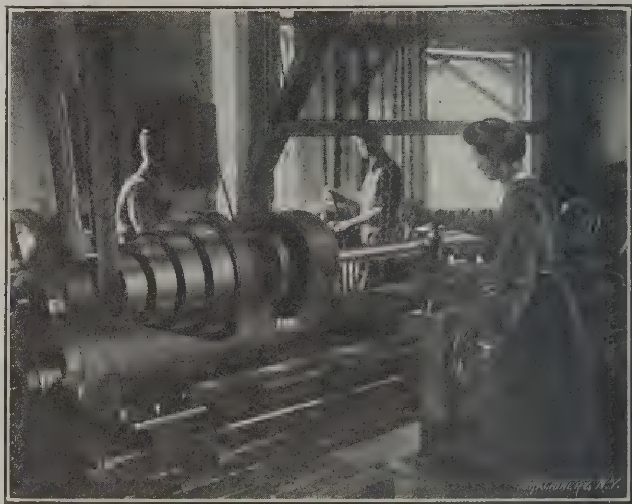


Fig. 3. Another View of the Shop. Note the Business-like Attitude of the Lady Machinist.

An important branch of the business is the repairing of inspirators and injectors, the Hancock and Penberthy instruments being the favorite boiler feeders in that section. A full line of repairs is kept in stock for each of the above-mentioned types, besides reamers and other tools for reseating worn valve seats and putting them into working order as good as when new. This work is almost entirely attended to by the lady machinist.

A few years ago a railroad was built within six miles of the shop, which opened up the surrounding country to a great extent, and work is now brought to the Parkins shop from miles around, coming in many cases from railroad towns where it could be shipped direct to machine shops in the larger towns, but the common saying is: "The people want a Parkins job."

Water is furnished for the boiler from a well about 60 feet deep, the water being pumped into a steel tank 6 feet in diameter and 10 feet high, located on top of a 90-foot tower, by a Marsh deep well pump, 6-inch cylinder by 36-inch stroke. This

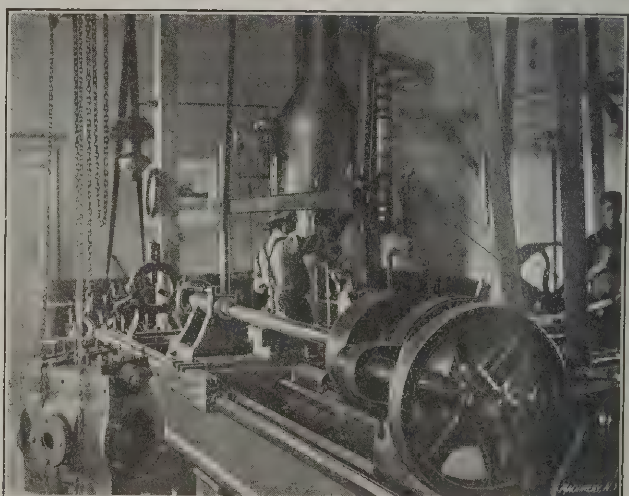


Fig. 4. The Boiler needs a little Attention.

tank also furnishes water for the house which, by the way, is fitted up with all modern city conveniences. Connected to the supply pipe from the tank is 100 feet of 2-inch fire hose, which gives first-class fire protection. The height of the tank insures a pressure which will throw a stream of water clear over any of the buildings.

Being so far from the base of supplies, the shop is obliged

to keep on hand a large stock of supplies, including many parts which the ordinary city shop would not carry; this stock includes, besides the usual supplies, many castings of the machinery used in the vicinity.

* * *

The time when the territory for great engineering feats was limited to America and Europe is past. Recent reports of the progress of the tremendous undertaking of the building

Fig. 5. Shipping a Repaired Job.

of a railroad from Cairo to Cape Town indicate that the work is rapidly being carried to completion. Last June the northern branch had reached within 400 miles of the Victoria Falls, and of the southern branch 2,000 miles are already completed. Between three or four thousand natives are regularly employed in the construction work. The last portion of 300

Fig. 6. The Home Part of the Shop and the Water Works.

miles, with seven bridges of more than 50 feet span, was completed in less than a year. From China is reported the completion of an enormous railroad bridge over the Yellow River, said to be the greatest undertaking of modern engineering in that country. The bridge is about 10,000 feet long, and consists of 103 spans, each varying in length between 75 and 110 feet.

TRACING, LETTERING AND MOUNTING.—2.

I. G. BAYLEY.

Tracing (Continued).

Sectioning.—Sections are shown in several ways. For working tracings line sectioning is far the better. Plates and sections in wrought iron or steel work may be blackened, as shown in Fig. 7. A narrow white space should be left between two pieces, as shown.

A pretty way of showing sections, especially in the case of show tracings, is to represent the various metals, woods, etc., by broken and full lines shown in Fig. 8. The examples are standard, although in case there should be any doubt as to whether they will be generally understood it would be well to make a small note to one side, naming the metal.

A neat little tool for section lining is easily made from a slip of wood a little thicker than the triangle or set square used by the draftsman, illustrated in Fig. 9. The notch cut in one side is a little longer than the side of the triangle. Resting the thumb upon the T-square, the first finger upon the sectioner and the second finger (all of the left hand) upon the triangle, they are alternately slipped along each time a line is drawn with the pen. With a little practice, sectioning can be done quicker than by using a triangle and T-square only, trusting to the eye for correct spacing. Section lining done this way looks very neat and even. Another section liner shown in Fig. 10 can be made to fit triangles having a recess in the center.

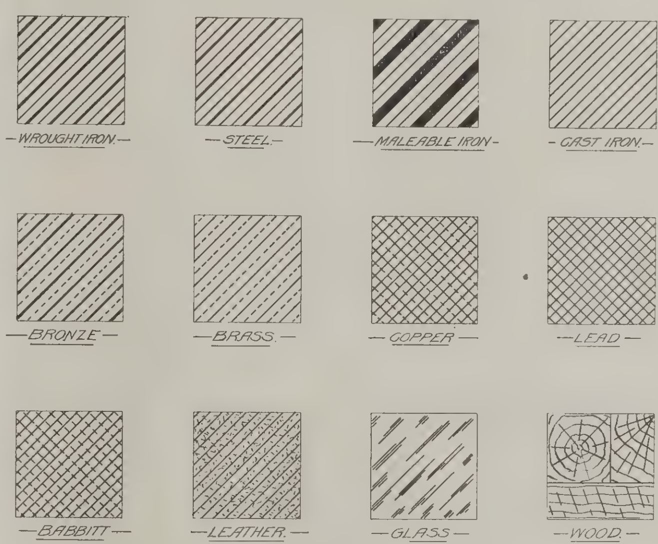


Fig. 8.

Views in section are sometimes colored, generally on the back, turning the tracing over and tacking it down again; or where there is much coloring to be done the tracing should be mounted as described under that head at the end of this article; otherwise the color will cause the tracing to buckle, giving it a very untidy appearance. Having stretched the tracing, you can be mixing the colors while it thoroughly dries. The colors should be rather thin and to make them run evenly a little prepared ox-gall should be mixed in well with them. This should not be omitted or the colors will present a very smudgy appearance. Some draftsmen use a small piece of soap in place of the ox-gall.

By trying the colors upon a scrap piece of tracing cloth or paper and turning it over, the proper shade may be obtained.

Following is a list of representative colors used in many offices:

Cast iron	Payne's gray.
Wrought iron	Prussian blue.
Steel	Crimson lake and small quantity of blue.
Brass	Yellow.
Copper	Crimson lake and yellow.
Brick	Crimson lake.
Wood	Burnt sienna.
Earth	Daubs of ink, Payne's gray, etc.

In the absence of Payne's gray a pale wash of India ink in

which has been mixed a little Prussian blue may be substituted.

Very neat sectioning can be made with crayons, toning them down with a soft rubber.

Dimensions and Center Lines.—Working tracings should have the dimension lines, center lines and all lines black ink, the idea being to make a neat, distinct tracing for use only, whereas a show or estimate tracing should be made with greater care. It is a well-known fact that many contracts have been awarded on the merits of a well-executed piece of work by the draftsman. The time and expense spent upon making a neat show tracing is never lost. Make the center lines of red ink or color, a fine long dash and dot line; the dimension lines one continuous line broken only where the figures come. See Fig. 11.

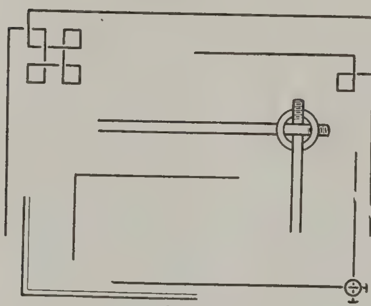


Fig. 12

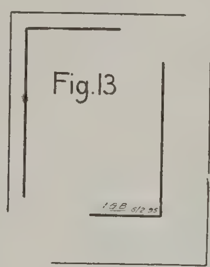


Fig.13

Fig. 14

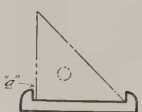


Fig.9

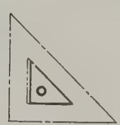


Fig.10

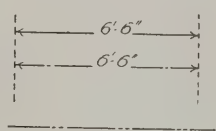


Fig.11

Border and Cutting-Off Lines.—Simple as these may seem, yet many well-executed tracings have been spoiled by either neglecting a border line or making a very poor one. A one-line border is perhaps the best and its thickness should match the work in hand, together with the size of the sheet. There should be plenty of margin between the border line and the

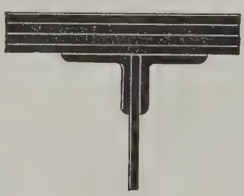


Fig.7

Fig.15

Fig.16

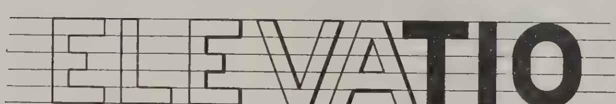


Fig.18

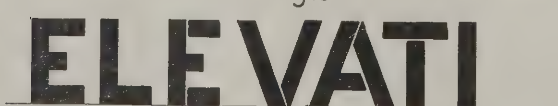


Fig.19

work. A fancy border line may be put around estimate or show tracings, of which a few samples are given in Fig. 12.

The cutting-off line should not be too near the border line, say, from ¾ inch to 1 inch. Nothing looks worse than to see a good tracing spoiled by cutting off within a quarter of an inch of the border line. Compare Figs. 13 and 14. The initials of the draftsman and date tracing was made should not be omitted.

Conclusion.—Attention to details is perhaps the true secret of making a neat tracing. No matter how trifling a detail may seem, it should be made as neatly as the rest of the work. Channels, angles, etc., in section should be made accurately. See Fig. 16. Don't make them, as is so often done, like Fig. 15.

When tracing a blueprint the tracing should be tacked down with few tacks, as it will have to be lifted quite often to see the work distinctly; in fact, in many cases it would pay to make a drawing from the blueprint and trace it.

Drawings which are faint or unfinished should by all means be made clear before attempting to trace them, thereby saving much patience, but in particular the eyesight.

In tracing from another tracing, a clean sheet of white drawing paper underneath will make it stand out clearly.

If the draftsman understands what he is tracing, the work will be much easier and he will not be likely to make so many mistakes as he would if tracing a number of meaningless lines.

The tracing should be wiped down occasionally with a clean, dry duster or cloth. Cotton sleeves are sometimes used to protect the coat. A sponge-rubber or piece of bread may be used to clean a tracing, but if proper care has been taken, a tracing can be taken up as clean and neat as when tacked down. A creased soiled tracing shows a bad workman. In some offices it is the practice to sponge the tracings down with benzine. Waterproof ink must be used by all means if this plan is adopted. When the tracing is complete, the draftsman should look over it carefully, trying to detect any errors, as all such count against him. The shop hands, as a rule, are only too pleased to point out any trifling mistake coming from the drawing office. However, accuracy as well as neatness and quickness is desirable

Lettering.

No matter how neatly or carefully the working lines of a tracing are made, if the lettering and figures are not up to the mark, the tracing will look poor in every sense of the word.

The young draftsman should, therefore, take especial care to get into a neat way of lettering and should devote a little

POSITION OF CYLINDERS.
STARBOARD ENGINES.
QUADRUPLE EXPANSION ENGS.
24-36-51½-74×42. Nos. 218-19-20-21.
THE GLOBE IRON WORKS CO.Y
CLEVELAND. OHIO.
SCALE ¾-1'-0" JUNE 6TH 1890.

Fig. 17.

of his spare time each day to this end if he wishes to excel as a neat draftsman. Neat letterers are in demand and are always sure of a position. Many cases have come to the writer's notice where a good letterer has been employed in his spare time to put on the figures and letters of other men's work, and although a poor tracing can be improved by neat lettering, to excel in both should be everyone's desire.

A good instruction book on this subject is difficult to find. Most alphabet books are ridiculous in the extreme; it would take longer to make the letters they describe than the whole tracing. The tracings would look insignificant in comparison with the wonderful lettering.

The letters and figures must conform to the other work—neither should be more conspicuous than the other. For this reason it is preferable for each man to complete his own tracing.

It is an easy matter to tell who made the various tracings in most drawing offices by the peculiar characteristics of each draftsman—this one by its poor lettering or that by a beautiful harmony of lines, letters and figures, the whole standing out in correct proportion, fine lines having small neat figuring, lettering, and arrow points to match, or heavy lines *vice versa*.

Nothing looks more uniform, neater, or is quicker done than good, plain, one-line lettering, even for the titles, though perhaps a little display may be given to them.

A few samples are here given. The small letters are for the general working parts of the tracings, notes, etc. Headings should be a little larger and the title, which will be referred to later, should be distinguished from the rest of the

work by using larger letters either blocked out or capital letters made with a heavier pen.

Figures should be made plain and simple, without the use of flourish or tailpiece. Fractions should be made with one figure immediately over the other instead of to one side. The vertical system of figuring is preferable to the slanting, especially with shop tracings.

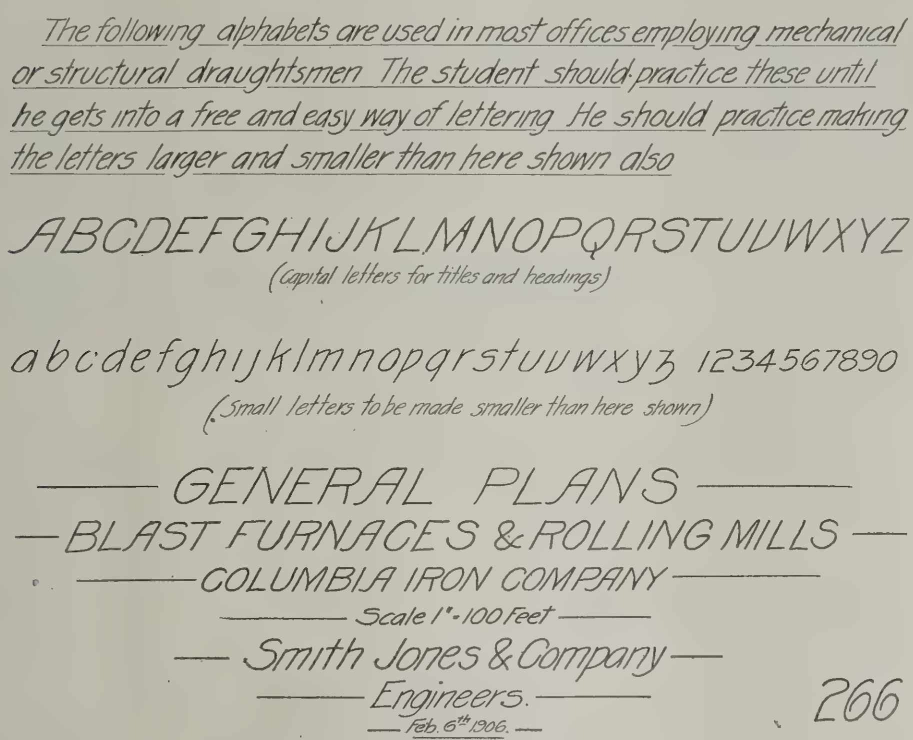


Fig. 20. Examples of Lettering.

For lettering, have plenty of black ink, but not too thick. The best kind of pen points are Esterbrook's No. 333 or Gillot's 303 for fine work. A heavier pen must be used for titles. Make the letters and figures with one stroke of the pen; do not go over them again, but get the required thickness, even with titles, by bearing on the pen more. A pen can be tempered when new by holding it in a lighted match, though pressing it on the thumbnail is generally sufficient.

Headings or Titles.—The heading or title should be in a conspicuous place, and as far from anything which may tend to crowd it as possible. The bottom right-hand corner of the

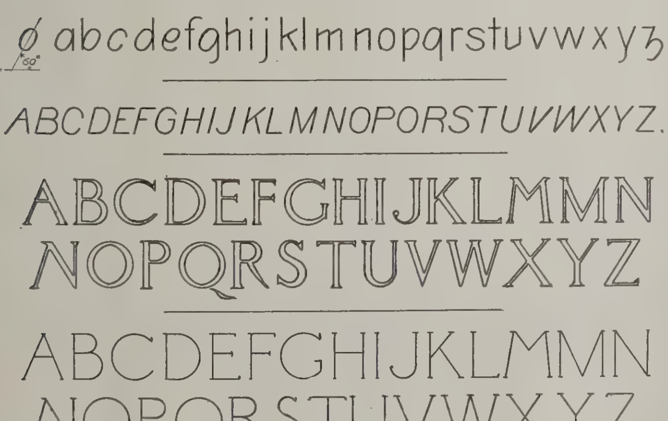


Fig. 21. Examples of Lettering

sheet is a good place. A heading sometimes looks better without lines drawn underneath, as shown in Fig. 17. This is entirely optional, however; if lines are put under they should not be too close to the letters.

Black letters are sometimes used, which can be made by drawing six pencil lines equally spaced, as shown in Fig. 18. The T-square and triangle are used and the letters can be made quite rapidly. They should afterwards be filled in or one edge of the letters made heavier, according to the nature of work in hand. Sloping letters can be made in the same way by using an adjustable-headed T-square or a special triangle made for that purpose.

Stenciling.—Sometimes headings, letters, figures and corner pieces are put on by means of stencil plates cut out of tin or copper sheets. A stiff, short stencil brush is used. The brush is moistened with water, not using too much, and is then rubbed along the stick of ink until it cannot absorb any more. Particular attention is called to this, as here is where so many fail in making clean and clear stencil work; the brush should never be dipped into a saucer of ink, or the ink applied with a pen.

The position for the title having been settled, pencil lines should be drawn on the cloth as a guide for the stenciling. Sometimes the title or heading is stenciled upon a spare piece of cloth or paper first, then slipped into place under the tracing and the stencil work done over it. This is a good plan, as the correct position may thus be obtained. If this is not done, the only way is to make a pencil tick mark after each letter to indicate the position of the next, as, of course, the stencil plate will hide all beneath it except the letter being stenciled. Then the letters must each be filled in, as shown in the first two or three letters of Fig. 19.

Even when the stencil guide referred to is made and slipped into place under the tracing cloth, a pencil guide line should be drawn and all letters stenciled exactly to it. The pencil lines and ticks are then erased. If the brush becomes dry, it may be moistened on the tongue without again rubbing it on the ink stick.

Draftsmen sometimes cut their own stencil plates out of stiff drawing paper, applying a coat of varnish on the upper surface.

Round Writing.—When referring to alphabet books, the writer should have made one exception at least, and that is the round writing system. It is easily learned and not soon forgotten. Letters and figures of all sizes and shapes can be made by using different graded pens. Books of instruction and an assorted box of pens may be had from any stationery store of importance. It is known as the Round Writing System of Lettering.

* * *

Designers, in general, in making use of malleable iron castings, proceed without definite knowledge as to the physical properties of this material, so far at least, as its tensile strength and elongation are concerned. Mr. G. A. Ackerlind read before the Scandinavian Technical Society recently a paper in which he gave some definite information as to the properties of malleable cast iron as made in that country. This information is doubtless applicable to American irons as well. He states that the tensile strength for this material varies between 40,000 pounds and 50,000 pounds per square inch. It has an elongation varying from 1 to 6 per cent with a reduction of area of ¾ to 3 per cent. The ordinary grade of cast iron having a tensile strength from 20,000 to 30,000 pounds per square inch is therefore only about half as strong as malleable cast iron; its compressive strength, however, is much greater. Malleable cast iron shrinks more in the mold than cast iron, but during the process of annealing a slight swelling takes place. If malleable castings have to be straightened by hammering, nothing is gained by heating them, the normal temperature of the surrounding air being satisfactory for this purpose.

THE CONDITIONS OF FAN BLOWER DESIGN.

The velocity with which air escapes into the atmosphere from a reservoir is dependent upon the pressure therein maintained and upon the density of the air. The pressure per unit of area divided by the density per unit of volume gives the head, usually designated as the "head due to the velocity." The velocity produced is that which would result if a body should fall freely through a distance equal to this head. In the case of the flow of water such a head always exists; as, for instance, when a stand-pipe is employed to produce the requisite pressure. Suppose the head of water to be 50 feet and its weight per cubic foot to be 62.5 pounds, then the pressure per square foot will be $50 \times 62.5 = 3{,}125$, and that per square inch $3{,}125 \div 144 = 21.7$ pounds. Its theoretical velocity of flow from an orifice at the bottom of the standpipe would be 56.7 feet per second, as determined by the formula for falling bodies, which is $v = \sqrt{2gh}$, in which

$v =$ velocity in feet per second.
$g =$ acceleration due to gravity.
$h =$ head in feet, here 50 feet.

In the case of air, however, an actual homogeneous head never exists, but in its stead we have to deal with an ideal head which can only be determined by dividing the pressure by the density. As the density of air is so much less than that of water, it is evident that for a given pressure the head will be far greater in the case of air. But the velocity of discharge is dependent only on the distance fallen which is represented by the head, whether real or ideal. As a consequence, air under a stated pressure escapes at vastly higher velocity than water under the same conditions. Calculated in the same manner the velocity of escaping air under a pressure of 21.7 pounds per square inch is 1,626 feet per second. By the employment of formulas based upon this theory, the elaborate basis tables published by the B. F. Sturtevant Co. have been calculated.

From the preceding discussion, it is evident that the pressure created by a given fan varies as the square of its speed. That is, doubling the speed increases the pressure four-fold. The volume of air delivered is, however, practically constant per revolution, and therefore is directly proportional to the speed.

The work done by a fan in moving air is represented by the distance through which the total pressure is exerted in a given time. As ordinarily expressed in foot-pounds, the work per second would, therefore, be the product of the velocity of the air in feet per second, the pressure in pounds per square foot, and the effective area in square feet over which the pressure is exerted.

From this it is evident that the work done varies as the cube of the velocity, or as the cube of the revolutions of the fan. That is, eight times the power is required at twice the speed. The reason is evident in the fact that the pressure increases as the square of the velocity, while the velocity itself coincidently increases; hence, the product of these two factors of the power required is indicated by the cube of the velocity.

The actual work which a fan may accomplish must depend not only on its proportions, but upon the conditions of its operation and the resistances which are to be overcome. Evidently, it is improper to compare fans when operating under such conditions that these resistances cannot be definitely determined. The simplest and most natural condition of operation is that in which the fan is operated without other resistance than that of the case; that is, with open inlet and outlet. For proper comparison of different fans, the areas through which the air is charged should bear some constant relation to the dimensions of the wheels themselves.

It has been determined experimentally that a peripheral discharge fan, if enclosed in a case, has the ability, if driven at a certain speed, to maintain the pressure corresponding to its tip velocity over an effective area which is usually denominated the "square inches of blast." This area is the limit of its capacity to maintain the given pressure. If it be increased the pressure will be reduced, but if decreased the pressure will remain the same. As fan housings are usually constructed, this area is considerably less than that of either the regular inlet or outlet. It, therefore, becomes necessary, in comparing fans upon this basis, to provide either the inlet or the outlet with a special temporary orifice of the requisite area and the proper shape, and make proper correction for the contracted vein. The fan is thus, in a sense, placed in a condition of restriction of discharge, which it approaches in practice only in so far as the resistance of pipes, passages and material through which the air must pass has the effect of reducing the free inlet or outlet of the fan.

The square inches of blast, or, as it may be termed, the capacity area of a closed fan, may be approximately expressed by the empirical formula:

$$\text{Capacity area} = \frac{DW}{x}$$

in which $D =$ diameter of fan wheel, in inches.
$W =$ width of fan wheel at circumference, in inches.
$x =$ a constant, dependent upon the type of fan and casing.

The value of x has been very carefully determined by the B. F. Sturtevant Company for different types of fans; but these values must be applied with great discretion, acquired through experience and a thorough knowledge of all the conditions liable to affect the fan in operation.

* * *

BRITISH STANDARD FINE SCREW THREAD.

The committee on screw threads and limit gages, a subcommittee of the Engineering Standards Committee supported by several engineering institutions in Great Britain, recommends the continuation of the use of the Whitworth form of thread as the British standard for screws ¼ inch and larger in diameter. For screws smaller than ¼ inch in diameter the committee recommends the adoption of the British Association form of thread with the same pitches as are now known as the British Association's standard (B. A.).

In regard to the pitches for screws ¼ inch and larger in diameter, the committee recommends the adoption of two standards. One of these is to be known as the British Standard Whitworth Screw Thread (B. S. W.), and retains the same number of threads per inch as is now in use in the regular Whitworth's system. The other standard proposed has a greater number of threads per inch for corresponding diameters and will be known as the British Standard Fine Screw Thread (B. S. F.)

The reason for adopting this latter standard was founded on the complaints of many manufacturers that the regular Whitworth standard gave altogether too coarse pitches for a number of purposes, and while the old system was well adapted for a variety of constructions, it was not the best obtainable for such designs where shocks and vibrations had to be taken in consideration.

The pitches for the system of fine screw threads are based on the formula:

$$P = \frac{\sqrt[3]{d^2}}{10}$$ for sizes up to and including one inch; and on the formula

$$P = \frac{\sqrt[8]{d^5}}{10}$$ for sizes larger than one inch in diameter. In the above formulas

$P =$ pitch, or lead of single-threaded screw, and
$d =$ diameter of screw.

A table giving diameters and corresponding number of threads per inch will be found below.

BRITISH STANDARD FINE SCREW THREAD.

Diam.	No. of Threads per in.	Diam.	No. of Threads per in.	Diam.	No. of Threads per in.	Diam.	No. of Threads per in.
$\frac{1}{4}$	25	$\frac{5}{8}$–$\frac{11}{16}$	14	$1\frac{3}{8}$–$1\frac{5}{8}$	8	$4\frac{1}{4}$–$5\frac{1}{8}$	4
$\frac{5}{16}$	22	$\frac{3}{4}$–$\frac{13}{16}$	12	$1\frac{3}{4}$–$2\frac{1}{8}$	7	$5\frac{1}{4}$–6	$3\frac{1}{2}$
$\frac{3}{8}$	20	$\frac{7}{8}$–$\frac{15}{16}$	11	$2\frac{1}{4}$–$2\frac{7}{8}$	6	......	..
$\frac{7}{16}$	18	1	10	3 –$3\frac{3}{8}$	5	......	..
$\frac{1}{2}$–$\frac{9}{16}$	16	$1\frac{1}{8}$–1 $\frac{1}{4}$	9	$3\frac{1}{2}$–$4\frac{1}{8}$	$4\frac{1}{2}$	......	..

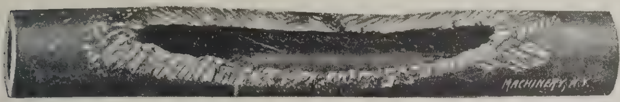
* * *

The output of asbestos in the United States for 1905, was 3,109 short tons.

ITEMS OF MECHANICAL INTEREST.

A RAT'S TRY AT HYDRAULIC ENGINEERING.

The rodent dwellers in the floors and partitions of an apartment building in Brooklyn attempted to make a passageway from their quarters on one side of a floor beam by gnawing through to the other side. They succeeded in their undertaking, as the people living in the flat below this floor discovered when deluged by a flood of water from above. The rats gnawed through the beam in a diagonal direction and encountered on the further side of the beam a lead water pipe in which there was the city water pressure. The pipe ran parallel with the beam and was so located that the rats were obliged to gnaw through it in order to gain a passage way. They continued in their diagonal course, however, eating away the pipe, as shown in the illustration, in spite of the large



The Pipe after the Job was Completed.

volume of water escaping. It was a job that probably made them hold their breath. The pipe was brought us by the engineer of the building as evidence of a good piece of hydraulic engineering and incidentally as an indication of the multifarious duties that fall to the lot of one in his position.

FRICTIONAL FEED MOTIONS

The principle used in the jeweler's drop hammer, by which a man is apparently able to lift a great weight by placing his foot in the stirrup at the end of the strap to which the drop is attached, has another application, as shown in the cut herewith. In the case of the drop hammer the strap passes over a rotating pulley at the top of the press. The pressure of the operator's foot in the stirrup draws the strap tight enough over the pulley so that the latter raises the drop through frictional contact.

The illustration, Fig. 1, shows this lifting device, as used by the New Britain Machine Co., New Britain, Conn., for raising the table of their mortising machine to bring the work against the cutters. This lifting motion is an instance of a device almost elementary in its simplicity, yet exactly meeting and accomplishing a variety of requirements. The frictional strap which raises the table passes over the pulley *B* which rotates in the direction of the arrow. One end of the

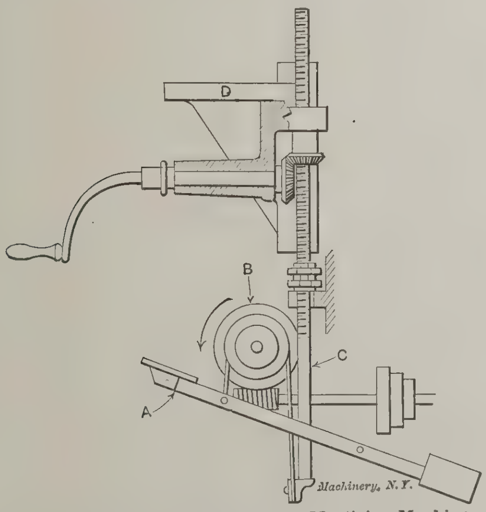


Fig. 1. Friction Feed Device for Mortising Machine.

strap is attached to the treadle, *A*, and the other end to the vertical screw, *C*, by which the table, *D*, is raised or lowered. A slight pressure of the foot upon the treadle results in a lifting force many times as great upon the table and even the greatest pressure cannot cause the table to exceed the rate of travel fixed at the feed cones. A light pressure slows the feed rate for hard spots and the natural weight of the foot on the treadle acts as a cushion when the table drops.

The frictional pulley used for raising the tables in these mortisers appears in section at *A*, Fig. 2, which also illustrates a novel method of clamping the pulley to the shaft, *B*, without the use of set screws. The requirements are such that the shaft cannot have a shoulder against which to clamp the pulley by means of a nut on the end of the shaft; and as it is necessary for the pulley to be removable, the method

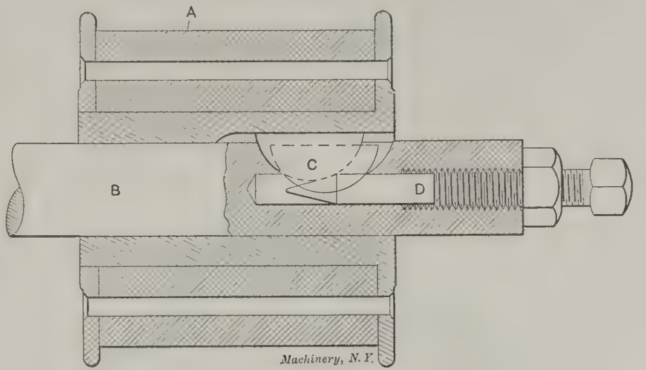
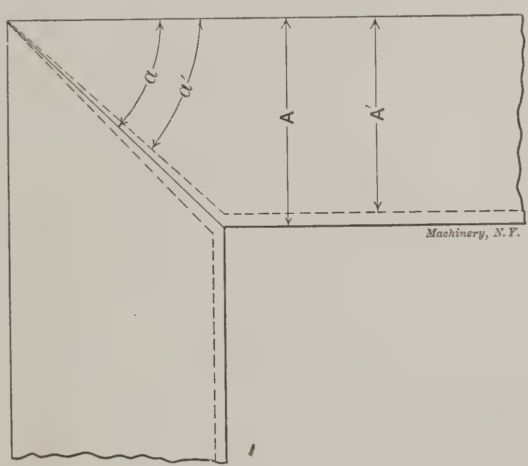


Fig. 2. Method of Holding Pulley to Shaft.

shown in the sketch was devised for holding it. A Woodworth key, *C*, is used, and this is forced out against the keyway milled in the bore of the pulley by means of a set screw, *D*, which enters a threaded hole in the end of the shaft.

CAUSE OF MITERED JOINTS DRAWING APART.

Why do the joints of mitered joint frames, such as picture frames, nearly always gap on the inside corners? If the reader will take the trouble to look at a wide picture frame having mitered joints he will find that while the outer corners are close together the inner corners are almost invariably gapping a distance of anywhere from 1-32 to 1-16 inch, or more. When the frame was fitted up a perfect joint, of course, was made, but as the wood seasons the drawing apart of the



Why Mitered Joints Open Up.

inside corners is an almost invariable result. The cause of this action has been the subject of considerable discussion among patternmakers and other woodworkers, and a variety of reasons have been assigned. The true explanation is very simple, and is illustrated in the sketch given herewith. It will be noted that the wider the frame the greater the gapping. This is caused by the fact that wood shrinks very little in length, the shrinking being almost altogether confined to the width. In the sketch the full lines indicate the original outline of one corner of a mitered joint frame, and the dotted lines the shape it takes after having seasoned. Inasmuch as the wood shrinks very little, or not at all, in length it follows that the outside dimensions of the frame remain practically unchanged, but the narrowing of the width *A* to *A'* changes the angle *a* to *a'*, as indicated by the dotted lines, so that the result must be a separation of the joint at the inner corners.

* * *

So long as we see the automobile carrying an extra tire or two, just so long may we regard it as an impractical vehicle for anything save pleasure—pleasure obtained at much cost and trouble.

CURIOUS CHINESE LOCK.

Through the courtesy of the Yale & Towne Mfg. Co., we are enabled to present the accompanying halftone, Fig. 1, showing a curious Chinese lock used for some time on a letter box in Doyer St., (within the purlieus of Chinatown) New York. Although of very simple construction and probably easily pickable by an expert, it nevertheless offers a degree of security sufficient for most purposes for which a lock of this type is commonly used. It will be noted that the lock is not only of the spring or self-locking type, but is also of

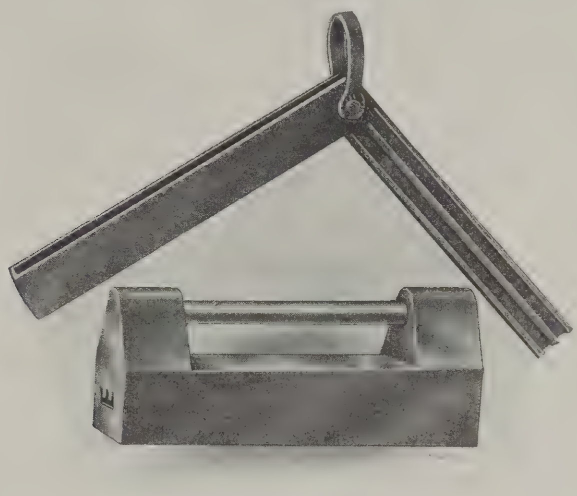
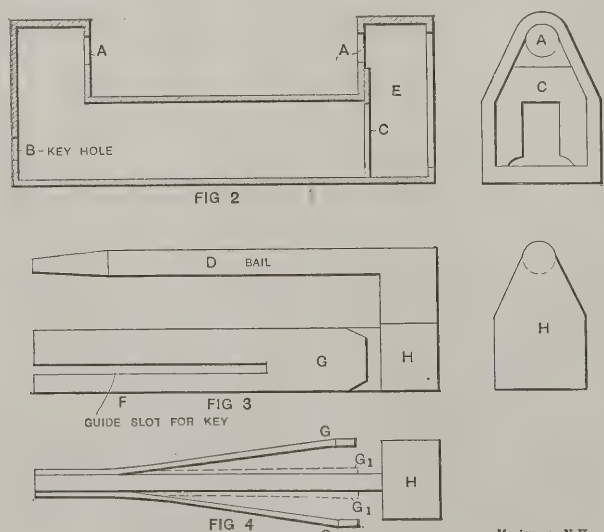


Fig. 1. A Chinese Padlock and Key.

the ejecting type, the shackle being partially forced out when the key is inserted. It is, we understand, a type of "padlock" largely used in China for trunks, portable boxes, etc.

The arms of the shackle are joined by the part *H* which fits closely in the opening *E* and is flush with the end. One arm of the shackle, it will be noted in Fig. 3, has two spring leaves *G*. These leaves spring outward when the lock is closed and the ends engage the sides of the partition *C*, this constituting the essential locking action. The key is of E-section and its insertion into the lock pinches the spring leaves together, unlocking the shackle and partially ejecting it from the case. The middle projection of the E-section performs no function, being a deception or "blind"; a channel-section key would answer the same purpose but such would not be inferred from the keyhole, of course. The security of the lock against pick-



Figs. 2, 3 and 4. Details of Lock.

ing lies quite largely, however, in the length of the key required, it being nearly three inches long in the working part. For convenience in carrying the key is made with a jointed handle into which it can be closed, as shown in Fig. 1.

The body or shell shown in section in Fig. 2, is made of sheet brass, soldered or sweated together at the corners, and is apparently made up of seven pieces carefully joined. This laborious make-up was doubtless followed in order to avoid the use of castings.

BLANKING AND PIERCING DIES FOR WASHERS.

C. F. EMERSON.

One of the simplest dies to make, coming under the head of blanking and piercing dies, is perhaps the die for blanking and piercing brass washers. The reason for this is that in making this die, the file and vise are not used; the construction and shape of this die are such as to allow it to be made by machinery.

To lay out a single washer die is a very easy matter, but to lay out a die for cutting two or more washers at one time, so as to cut the greatest amount of blanks from the least amount of stock, is not understood as it should be.

One of the reasons for this is that it is the custom in some shops to have the foreman, or some one else appointed by him, lay out all the dies before they are given to the die maker to work out.

In laying out a washer die for blanking two or more washers at one time, one of the main points to be remembered is that all the holes from which the blanking and piercing are done must be laid out in an exact relation to each other, so as to

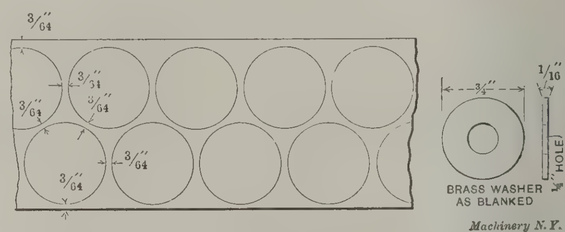


Fig. 1. Stock after having been run through the Die in Fig. 2, and Washer.

eliminate the possibility of "running in" (i. e., cutting imperfect, or half blanks, by cutting into that part of the metal from which blanks have already been cut). The required amount of blanks must also be considered, for it sometimes happens that the amount wanted does not warrant the making of a die that will cut more than one at a time.

Fig. 2 shows how a die is laid out for blanking and piercing two washers at one time, so as to use up as much of the metal as possible. As shown, the ¾-inch holes marked *C* and *D* are the blanking part of the die, while the ¼-inch holes

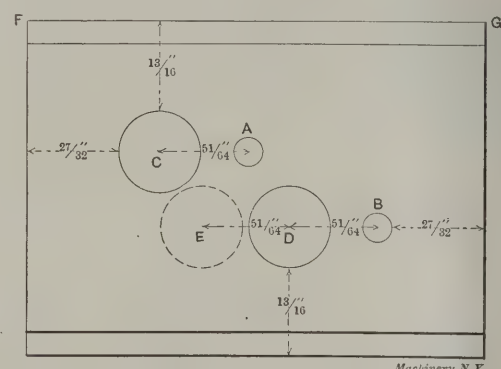


Fig. 2. Plan View of Die for Punching two Washers.

A and *B* are the piercing part. The distance between the center of *C* and *A* is 51-64 inch, as is also the distance between *D* and *B*. By referring to Fig. 1, which shows a section of the stock after it has been run through this die, it will be seen that there is a narrow margin of 3-64 inch of metal, known as "the bridge," between the holes. In laying out the die this margin must be taken into consideration, which is done in this manner. Diameter of washer to be cut plus bridge equals distance from center to center, viz., ¾ + 3/64 = 51/64.

The dotted circle shows that the die is laid out so that one washer is skipped in running the metal through at the start. This is done in order to make the die a substantial and strong one. It can be very readily seen that if the circle *E* was the blanking part instead of *D*, the die would be a frail one, and would not be strong enough for the work for which it is intended.

Another important point in laying out a die of this kind

is to lay out the die "central," *i. e.*, laying out the die so that when it is keyed in position ready for use in the center of the die bed, it will not have to be shifted to the right or left side in order to make it line up with the punch.

It may not be amiss to say in connection with the above that the punch back which holds the blanking and piercing punches in position should also be laid out "central"; this will be more fully described later on.

Fig. 4 shows the layout for blanking and piercing three washers at one time, and hardly needs any explanation; the explanation given in connection with Fig. 2 sufficiently explains Fig. 4.

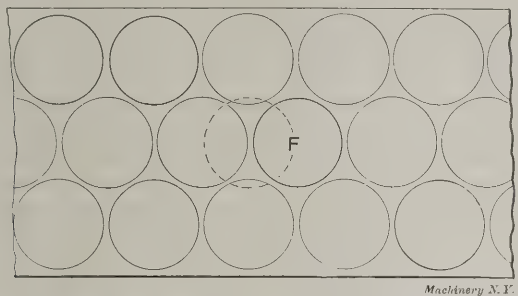


Fig. 3. Stock, after having been run through the Die in Fig. 4.

Fig. 3 shows a section of the stock after it has been run through this die. It can be seen that the holes match in very closely together, and that very little stock is left. It is also seen that the three holes punched are not in a straight line, in so far as the width of the metal is concerned. This is done in order to save metal; the dotted circle *F* is merely drawn to show that wider metal would have to be used if the holes were in a straight line.

Fig. 5 shows the plan of a die for blanking and piercing eight washers at one time. The parts which are numbered are the blanking parts, while the parts that are lettered are the piercing parts of the die. This die is laid out similarly to Fig. 4, with the exception that there is provision for eight blanks instead of for three. Fig. 6 shows a section of stock after it has been run through this die. To give a better idea as to how the blanks are punched out in the manner shown, the sixteen holes in the metal from which blanks have been cut are numbered and lettered the same as the die. It should be understood that the metal is fed through in the usual way, which is from right to left, and that the ¼-inch holes are first pierced out, before the ¾-inch blanks are cut.

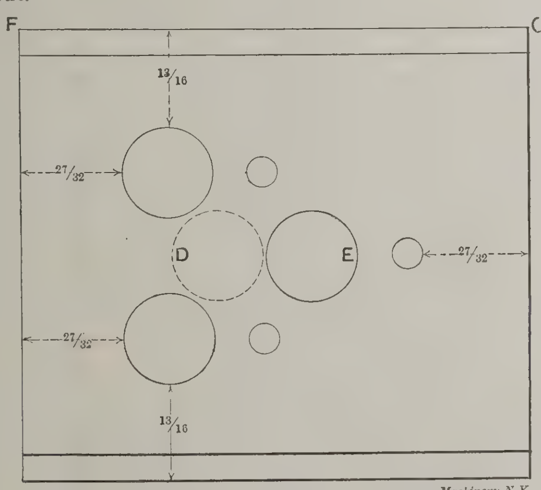


Fig. 4. Plan View of Die for Punching three Washers.

By referring again to Fig. 5, the layout for cutting two, three, four, five, six and seven blanks can be determined. The parts numbered and lettered 1—*A* and 5—*E* are the layout for two blanks. For three blanks: 1—*A*, 2—*B*, and 5—*E*. For four blanks: 1—*A*, 2—*B*, 5—*E*, and 6—*F*. For five blanks: 1—*A*, 2—*B*, 3—*C*, 5—*E*, and 6—*F*. For six blanks: 1—*A*, 2—*B*, 3—*C*, 5—*E*, 6—*F* and 7—*G*. For seven blanks: 1—*A*, 2—*B*, 3—*C*, 4—*D*, 5—*E*, 6—*F*, and 7—*G*.

The die bed used for holding the die in Fig. 5 in position when in use should have its dovetail channel running in the direction *KL*, while the dovetail channel for the dies shown in Fig. 2 and 4 should run in the direction *FG*. The reason for this is the longer bearing surface for the dovetail obtainable by such arrangement.

It should be remembered that all holes in dies of this kind are lapped or ground to size after hardening; they should be perfectly round and have 1 degree clearance. In some shops the holes are left straight for ¼ inch, and then tapered off 2 degrees.

An important point to bear in mind in making the punch is to have a perfect "line up." It may not be generally known, but it is nevertheless a fact, that blanking tools that blank, or that pierce and blank two or more blanks at one time, will run longer without sharpening, cut cleaner blanks, and, in fact, give all around better results, if the punches are a perfect "line up" with the die than if they are lined up in the so-called "near enough" way.

Perhaps some one will ask, "What is meant by a perfect line up?"

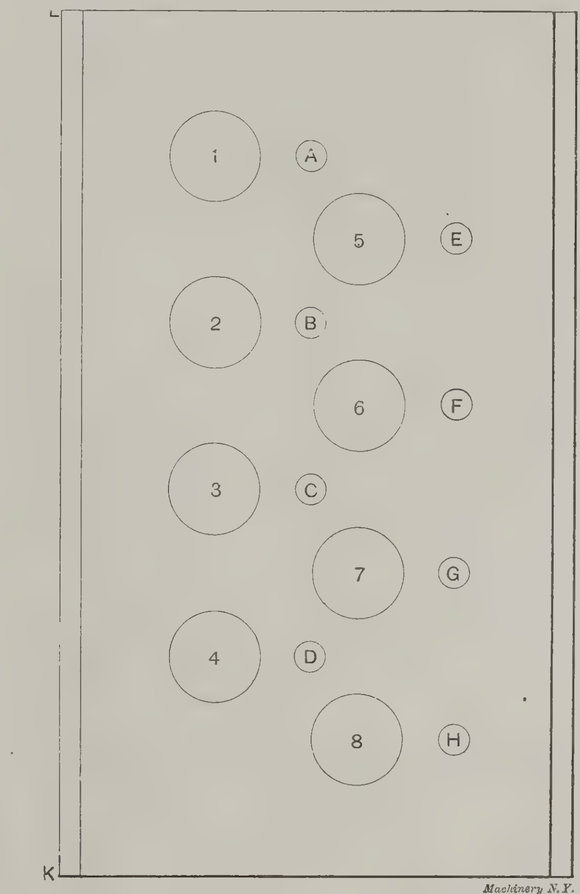


Fig. 5. Plan View of Die for Punching eight Washers.

A perfect line up as referred to in the above is a line up that will allow a punch that consists of two or more punches to enter the die the same as if the punch consisted of just one punch.

The advantage of the perfect line up over the other is that when in use the punches do not come in too close contact with the edge of the die. They enter the die, but do not bear against the edge in such a way as to dull the die, or round over the sharp cutting edge of the punch.

A punch that is almost a perfect line up will enter the die, but it requires more force to make it enter. Why? Because in entering one of the punches for instance, rubs hard against the side of the die, and if set up in the press and allowed to run, that punch, no matter how small, will dull the edges of the die as well as the edge of the punch itself. The result is that the press must stand idle while the tools are being sharpened, and if the real cause of the trouble is not remedied it is "the same old thing" over and over again.

Just a few words in regard to making the punch. In making the punch, the punches must be made so that they will fit the die not too loose, nor too tight. The blanking punches are hardened and ground to size. The taper shank is finished

to size after hardening, so that when the punches are driven into the punch back they will stand straight and not lean to one side.

In laying out the dovetail punch back, first clamp the back central on the face of the die. This is done so that when the punches are driven in position in the punch back, and set central in the ram of the press, ready to be used, no shifting is required in order to make the punch line up with the die, which is keyed in the center of the die bed.

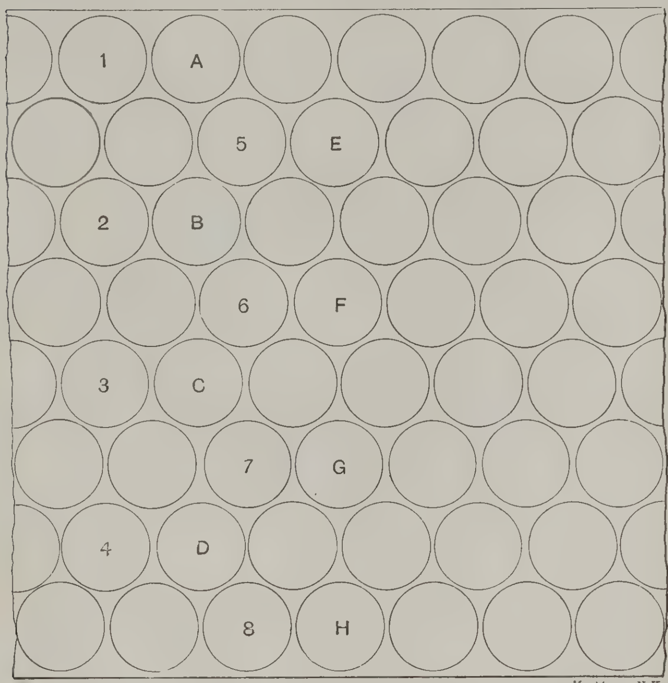


Fig. 6. Stock, after having been run through the Die in Fig. 5.

After clamping the punch back in this position, the blanking part of the die nearest the end is scribed on the face of the punch back. Do not scribe all the holes and rely upon finding the center of each circle thus scribed with a pair of dividers, and then true up these centers on a faceplate in order to get perfect line up; this method increases the chances of error, especially when there are six or eight punches to be set in position. A better way is to scribe one circle as stated

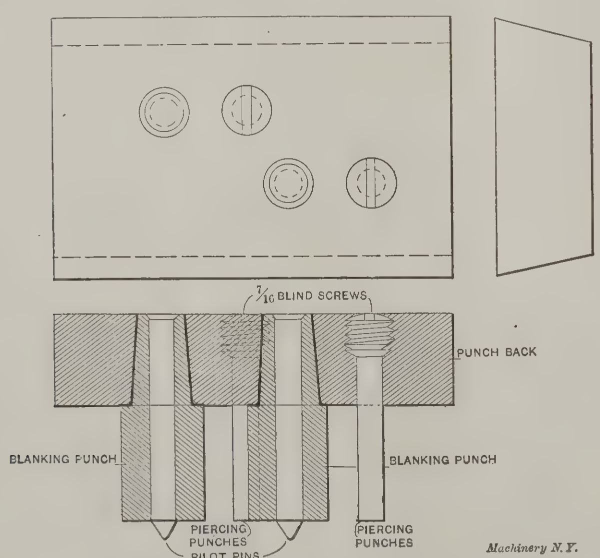


Fig. 7. Punch Back, with Punches Inserted.

above, and remove the punch back from the face of the die; find the center of the circle scribed; true up this center, and drill and bore out the hole to fit the taper shank of the blanking punch.

Fig. 7 shows how a punch of this kind is made. The punch as shown is used with the die shown in Fig. 2. After the hole is bored to size, the already finished blanking punch is driven in tight in the manner shown. Two narrow parallels say ½ × ¾ inch are now laid on the face of the punch back, and the blanking part of the die that corresponds with the punch driven in is slipped over the same, until the face of the blanking die rests upon these parallels, after which the die is clamped tightly thereon. The next hole is now trued up with a test indicator until the hole runs dead true. The die is then removed, and the hole for the taper shank is worked out, and the punch driven in. Where there are more punches to be set in, the same method is used until they are all in position. This insures a perfect line up, providing that ordinary care and precaution has been used in doing the work.

In boring out these holes it is best to use a bolster having a dovetail channel, and to hold the punch back in position with a key.

This is better than using straps to fasten the punch back to the faceplate, as the straps are likely to interfere with the parallels and the die, when locating the exact position for the holes to be bored.

In locating the position for the piercing punches it sometimes happens that the holes are so small that they cannot be bored. The holes are then transferred by a drill that runs true and is the same size as the holes in the piercing die, the die being used, so to speak, as a drill jig.

Fig. 7 shows how the piercing punches are held in position. The punches are made of drill rod, and are prevented from pushing back by hardened blind screws as shown. If thin, soft metal is used, the method for holding the two pilot pins in position shown in the article "Making a Blanking Die," in the June issue, may be employed, or the method shown in Fig. 7.

When the piercing punches are made and held in position as shown in Fig. 7, a spring stripper is sometimes used, and is fastened to the punch back, and the holes for the piercing punches in this stripper are made a sliding fit, in order to prevent the punches from springing or shearing. When the ordinary form of stripper is used, the piercing holes are also made a good sliding fit.

* * *

Spoiled work is probably inevitable in every shop, and it is a considerable problem to handle it in a way that shall be just to the workmen and still protect the interests of the concern. Some men are careless, and if they make a mistake which spoils a piece of work, the incident soon passes out of their minds, and repetitions are common. But it is one thing to make a mistake that spoils a piece of work and another to have it well advertised to the rest of the men in the shop. A conscientious workman earnestly endeavors to avoid spoiling work, and if such a mishap does befall him no one regrets it more than he, and even the most careless, happy-go-lucky chap shares his keen regret to some extent, at least, when the fact is made semi-public in a way that is followed in a certain New York State establishment. Whenever a job is spoiled in this shop it is carefully ticketed with the name of the "spoiler," date, circumstances, cost, etc., and is then prominently exhibited in a so-called "graveyard" for a certain number of weeks, to be there seen and sarcastically commented on by the other workmen. The frantic efforts of these men to avoid this form of "burial" are well worthy of a nobler object, oftentimes, it is said, and it is claimed that salutary effects of the scheme are most marked.

* * *

No improvement in blast furnace practice made in recent years is likely to be of such far-reaching importance as the application of the dry blast, developed by Mr. Gayley. It was discovered that the variations in humidity of the atmosphere were largely responsible for many mysterious troubles in blast furnace practice. The application of the refrigerating principle to the blast so as to reduce the humidity and make it uniform was a long step forward in determining uniform results. A recent example of blast drying apparatus installed is that of the E. & G. Brooks Iron Co., at Birdsboro, Pa. The De La Vergne Machine Co., New York, are putting in refrigerating machinery of 350 tons daily capacity for drying the blast, the air being passed over coils of pipe containing cold brine or ammonia. All excess moisture above a predetermined point is deposited on the pipes, the part remaining being practically constant, so that the humidity of the blast is uniform.

SPRING SCREW THREADING DIES—A CRITICISM.

I was greatly interested in the article in the August number on spring screw threading dies. It struck me as not being written from a practical standpoint, for while most of Mr. Oberg's points are plausibly taken, the difficulties encountered in the use of such dies are somewhat different both in cause and effect from those he enumerates. As one who has had considerable experience in both making and using them, the writer would like to give his views.

In the first place, screw-machine operators who are looking for extreme accuracy in the form of the threads do not use the spring die but prefer the so-called "button" die, which is easy to manufacture and which will give almost faultless results when used on high-grade machines by an experienced man. The chief objection to its use is that it will not stand the abuse which the spring die will and once it is seriously injured cannot be made to do satisfactory work afterward, making the loss on dies heavy when used on rough work or on machines that are abrupt or inaccurate in their movements. A button die would hardly stand up all day threading open-hearth steel with the scale still on, as the writer has seen the other type do.

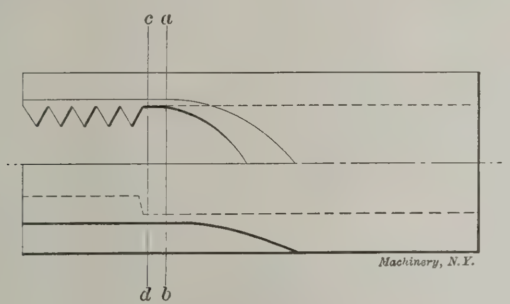


Fig. 1. Spring Screw Threading Die.

Mr. Oberg's method of making the perfect die by taper hobbing from the rear would be all right if we could rely on perfect hardening, but the chances are that when his die came from the hardener it would be no better in lead or form of thread than the die hobbed straight and oversize. If such a die should spring in 0.002 inch say, it would have to be annealed, rehobbed and rehardened with the chance of the same thing happening again, or else lapped out to correct size, which would be a very costly job. A straight die hobbed oversize under the same conditions would still be oversize and could be sprung down. At the same time the error in the form of thread due to springing the prongs down to size need not be over one-third of a thousandth for a 20-pitch thread, an amount which would not be noticed except by an expert gage maker.

Grinding the outside of spring dies is not practicable, and under manufacturing conditions is impossible, as can easily be seen when we take for example a die of ½ inch outside

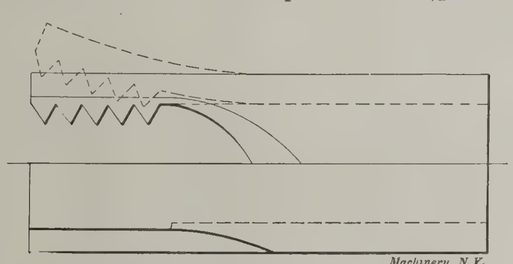


Fig. 2. Effect of Improper Hardening of Spring Screw Threading Dies.

diameter for cutting a 5/32 thread. It would have to be screwed on to a 5/32 threaded arbor with just enough tension to hold it, but not enough to spring the die—a condition which could hardly be met without making the die with lugs on the end of the prongs for a clamp ring, said lugs to be ground off after the die was finished.

The principal troubles encountered in the manufacture of these dies are due to improper handling of the die in hardening and are three in number, as follows: First, imperfect lead, due to unequal lengthening or shortening of the prongs which, with poor steel, is sometimes so bad as to spoil the dies; second, springing out of the prongs in a curve so that when closed down to size the die cuts a taper thread the length of the thread in the die, making it impossible to thread up near a shoulder; third, twisting of the prongs so that when closed down the contact with the piece to be threaded is not on the cutting edge of the teeth, but is back of it, causing a drag which always makes a rough thread and sometimes breaks off the screws.

The first trouble is not much to be feared where good steel is used and the proper temperature is obtained in hardening. The second and third are caused by the way the die is heated and dipped, in connection with the peculiar shape of the back end of the prong where the milling cut leaves off, as shown in Fig. 1. The die should never be heated back of the line *a b* where the curve begins, and need not be hot enough to harden back of line *c d* at the end of the teeth. If this is strictly adhered to the die will come out practically straight, while on the other hand if the die is hardened up into the curve it will always spring badly and even when it is properly dipped, if it is heated too far up, the hardening will run up far enough to cause trouble. Figs. 2 and 3 show the effect of improper hardening.

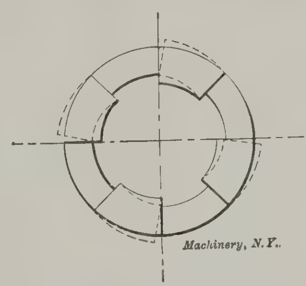


Fig. 3. Effect of Improper Hardening of Spring Screw Threading Dies.

Mr. Oberg's tables are good as far as they go, but it often happens that users of dies wish to use other outside diameters for special reasons. In such cases the following proportions will be found to work well:

The length should be 2½ times the outside diameter, the flute 3/5 of the length, and the finishing hob oversize in the proportion of 0.01 inch for every inch of the outside diameter. The flutes should be cut with a 60-degree mill for a three-fluted, or a 45-degree mill for a four-fluted die, and should be cut clear through, as the tie left by not cutting through is of no value if the die is properly hardened; it is also hard to grind out without drawing the temper. No machinist would try to turn iron or steel in a lathe with a tool

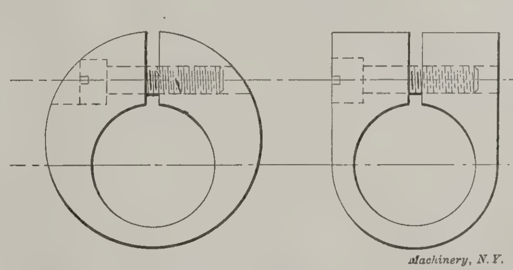


Fig. 4. Clamp Collars for Spring Screw Threading Dies.

having no top rake and, on the same principle, for wrought iron and steel, the cutting edge of the die should *always* be milled ahead of the center in the proportion of 1/64 for every ¼ inch of the diameter of the thread. For rod, brass and other similar material of a low tensile strength, more satisfactory results may be obtained by fluting the dies on the center.

The taper closing ring is a hobby with some operators, but has the objection that when used on automatics the amount of drive necessary to close the die is not sufficient to hold it from throwing the ring off when indexing, and it is nothing uncommon to see it tied back with a piece of string, cramping the die out of shape. In Fig. 4 are shown two forms of clamp collars which work well and which are superior to the one most commonly used.

E. A. JOHNSON.

Hartford, Conn.

* * *

First class office buildings in lower New York cost about 40 cents per cubic foot and rent for $1 to $1.20 per square foot yearly.

A POWERFUL HOMEMADE SLOTTER.

Several years ago McIntosh, Seymour & Co., Auburn, N. Y., felt the need for a vertical planer or slotter of large capacity to be used on the large vertical and horizontal engine work which they are engaged in. Not finding the kind of tool on the market that they required they resolved to build it, and the result is a very creditable home-made tool containing a number of interesting features. The machine has fulfilled all expectations and is a powerful tool in action. It is particularly well adapted to facing off the ends of vertical engine frames or columns, the floor plate in front having ample capacity for the largest sizes yet built by the company, and this means 7,500 H. P. The general appearance of the tool is shown in Figs. 1 and 3, Fig. 1 showing it at work on the flanges of a large vertical engine cylinder. The line drawings, Figs. 2, 4 and 5, together with the following dimensions will give a fair idea of the design and construction.

The cross-rail carrying the two tool saddles is operated by a screw 4½ inches diameter, ½ inch pitch, triple thread, giving 1½ inch lead. The nominal stroke is 10 feet and the length of the cross-rail is 10 feet 1 inch. The feed of either head or saddle on the cross-rail is 7 feet, and each head has independent cross power feed. The screw nut is 16 inches long and is made of babbitt in halves. These halves are forced into a cast-iron sleeve and keyed in place. This construction has always worked very satisfactorily, giving no trouble whatever.

The screw thrust is taken on a double roller thrust bearing. The rolls are cylindrical instead of conical shape, which would be called for to make them theoretically correct, but they have never given any trouble although the speed of the screw on the reverse runs up to 450 revolutions per minute. The bearing is designed for a tool thrust of 20,000 pounds, and the actual thrust of the screw due to the inertia of the moving parts at the beginning of every reverse stroke amounts to more than 25,000 pounds. The vertical movement of the cross-rail is reversed by tappets similar to an ordinary planer, these being arranged to actuate the belt shifter by means of which the actuating screw is reversed. These tappets are counterbalanced and their position can be altered quickly by means of two cranks at the floor and geared to

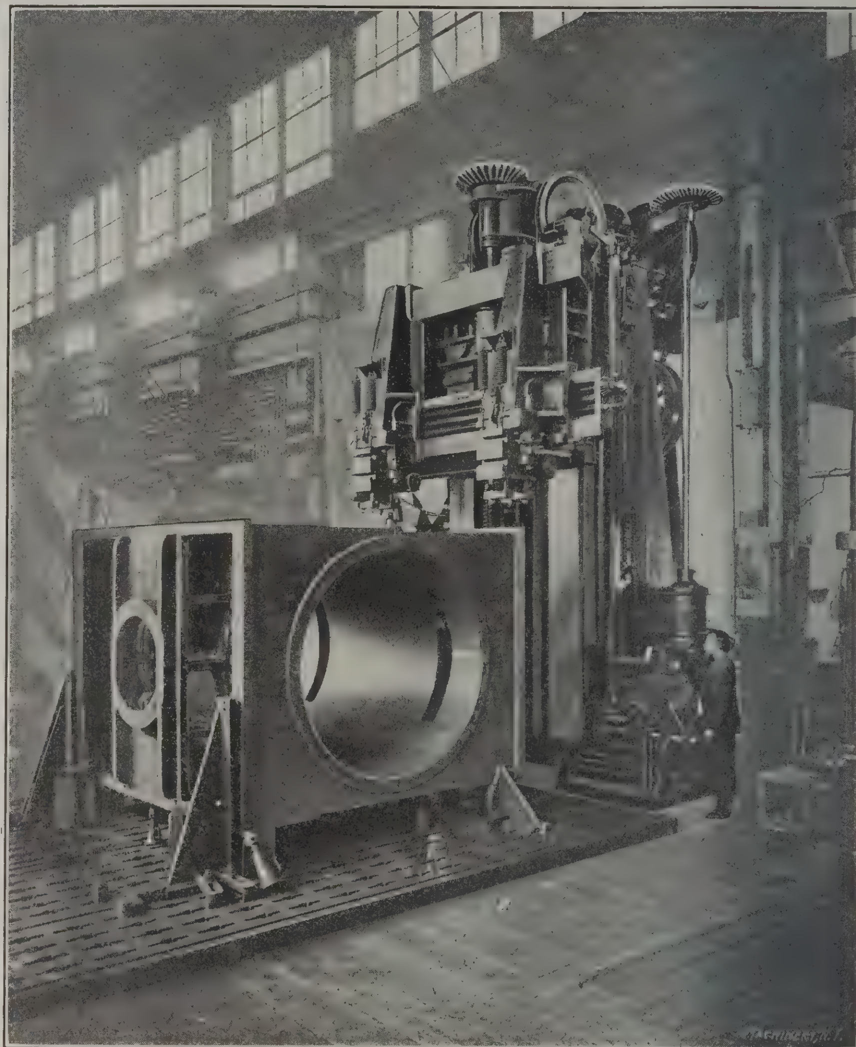


Fig. 1. Slotter at Work on Cylinder Casting.

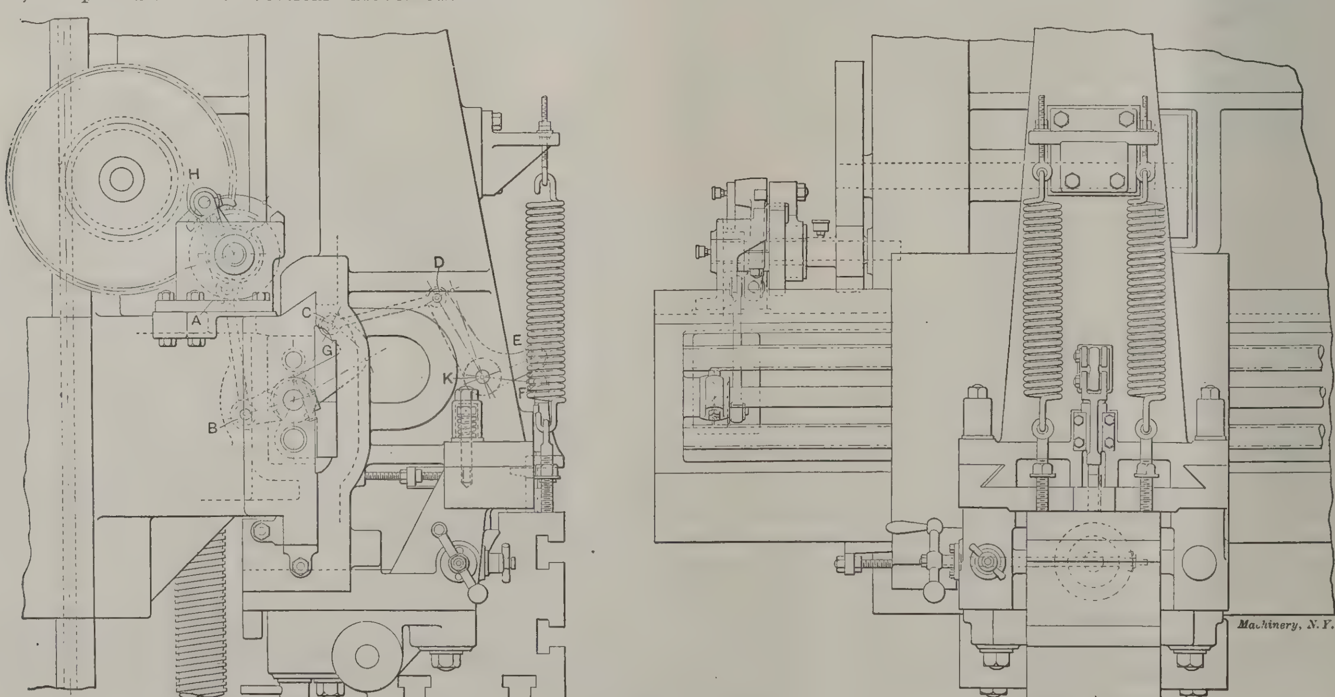


Fig. 2. Saddle of Slotter.

the tappet shifting screws so that a quick and convenient adjustment of both ends of the stroke can be made while the machine is running. This tappet shifting mechanism will be noticed in the side view of Fig. 5. The carriage carrying the cross-rail is counterbalanced. The counterbalance weighs 23,000 pounds and is situated inside the column, being carried by wire ropes running over sheaves. It was found that the inertia of the counterbalance at reversing amounted to more than its weight and it was necessary to increase the number of ropes carrying the counterbalance sufficiently to allow for this in order to secure freedom from breaking the ropes.

The column has a forward and backward feed of about four feet and in addition to the regular power feed it has a rapid power feed for bringing the machine up to the work, this feed carrying with the column all the operating mechanism, including the motor. The column feed and both saddle cross feeds can be operated from either side of the machine by hand, using stationary ratchet levers at the floor. The saddle feeds can also be operated by hand ratchets situated on the cross-rail near the work. In addition to these feeds a short movement of about 4 inches is provided in the tool-heads for advancing the tools to the work. The details of this are included in the view of the saddle, Fig. 2. Fig. 2 shows a relief gear for clearing the tool on the return stroke which does not now appear in the machine for the reason that it was discarded after being built, it having been broken by feeding the saddle too far out on the cross-rail and considerable change of design being necessary to avoid recurrence of the accident.

The machine is driven by a 25 H. P. General Electric motor arranged so that speeds can be ranged from 550 to 750 revolutions per minute, these speeds giving a cutting speed of from 12 to 20 feet with a return speed geared 3 to 1. The machine will work with cuts from 1¼ to 1¾ inch on both tools with feeds up to ¼ inch without showing any weakness or trembling; feeds over 1-10 inch are not desirable, however, on account of the tendency of the tool to break out the casting at the end cut. Its weight is 222,000 pounds.

* * *

CASEHARDENING WROUGHT IRON.*

Wrought iron is nearly pure decarbonized iron and is not possessed of the property of hardening. Articles made from wrought iron may be externally converted into steel without depriving the interior of its natural character of structure. The process is called "casehardening."

The object of casehardening is to obtain an external steel encasement with a core of fibrous iron in the center. The effect is produced in a perfectly air-tight box with animal carbonizing matter. The box should be made of plate or cast iron from ½ to 1 inch thick, the size and thickness of the box depending on the articles to be operated upon. The articles are put in the box in alternate layers with the carbonizing ingredients, commencing at the bottom of the box say with a layer of granulated bone 1 inch thick; upon this a layer of the articles is placed, then another layer of bone about ¾ inch in thickness, and so on until the box is nearly filled, finishing with a layer of bone on top of the articles, which should be 1 inch deep so as to well protect the first or top layer of articles and prevent blistering. The packing completed, the lid is put on and hermetically sealed or luted with loam or fire-clay.

The box or boxes are now placed in a suitable furnace. The furnace should give a uniform heat of about 1350 degrees F. Overheating is injurious, and will crystallize or make the articles brittle. In heating wrought iron for casehardening there are several considerations, the principle ones being heat and duration of time for carbonization, same being governed by the size or bulk of the work to be casehardened.

Heating in point of importance stands first, for if the primary cause of bad casehardening could be traced, its origin in a majority of cases would be found in bad heating. There is no operation connected with casehardening which requires more watchfulness and gives more anxiety than proper heating. It may therefore repay us to examine with care the conditions to be observed in obtaining results. The heat must be constant and uniform and should never exceed 1350 degrees F., for the degree of heat will have a bearing on the fibrous structure of the material. A high and excessive heat will render the material brittle and if the article is light in structure it is apt to break easily in service; therefore, it behooves us not to overheat or unevenly heat articles to be casehardened. Consequently keep the furnace at a regular or constant temperature, for if the articles to be casehardened are overheated the damage is done in so far as a fibrous structure is concerned; the article is hard but the interior is brittle and crystalline when it should be fibrous and showing a dark or black appearance of its natural structure with a fine grained surface analogous to tool steel.

Where I am employed we do a great deal of casehardening, all of which is done under my supervision and direction. We caseharden as high as five tons of wrought material in 24

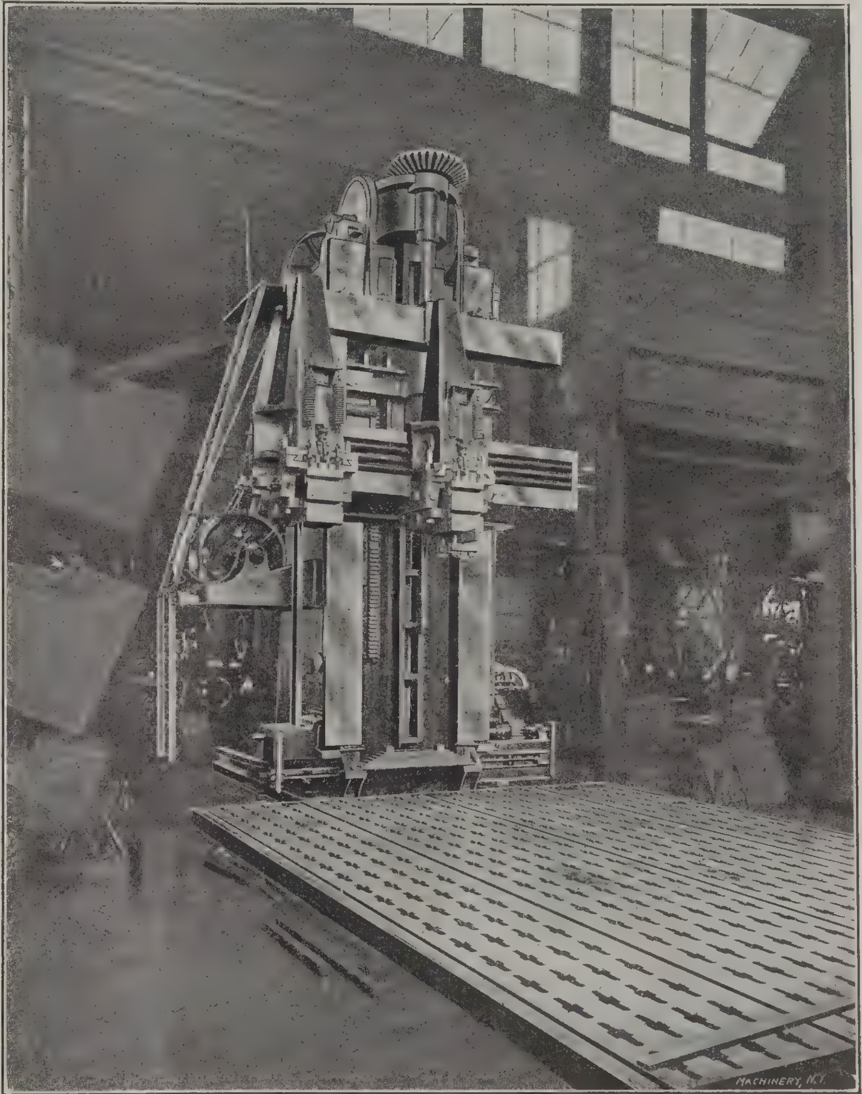


Fig. 3. General View of Slotter and Floor Plate.

* Abstract from a paper read by Mr. George F. Hinkens before the International Railroad Blacksmiths' Association Convention, Chicago, Ill., August 21-23, 1906.

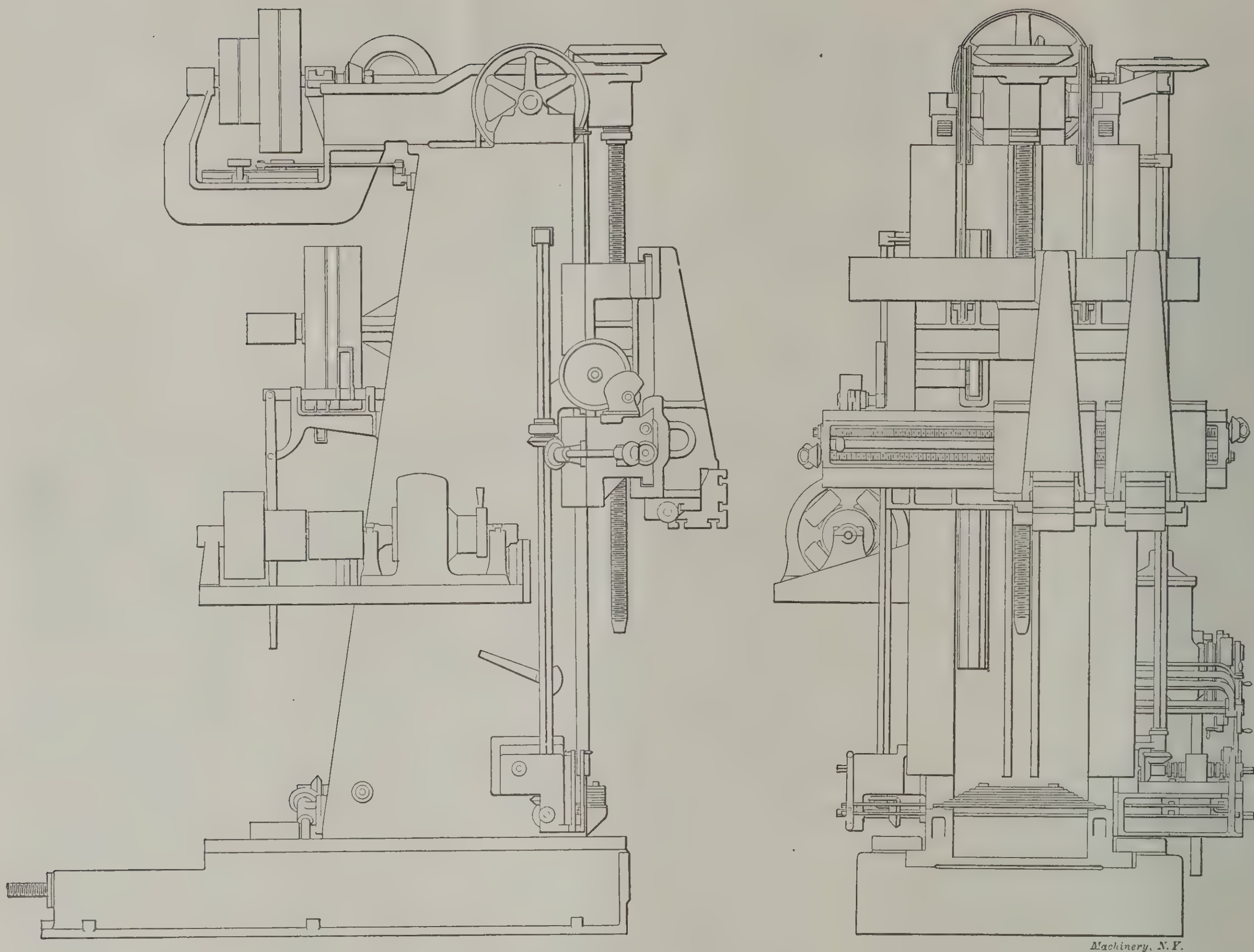


Fig. 4. Front and Side View of Slotter.

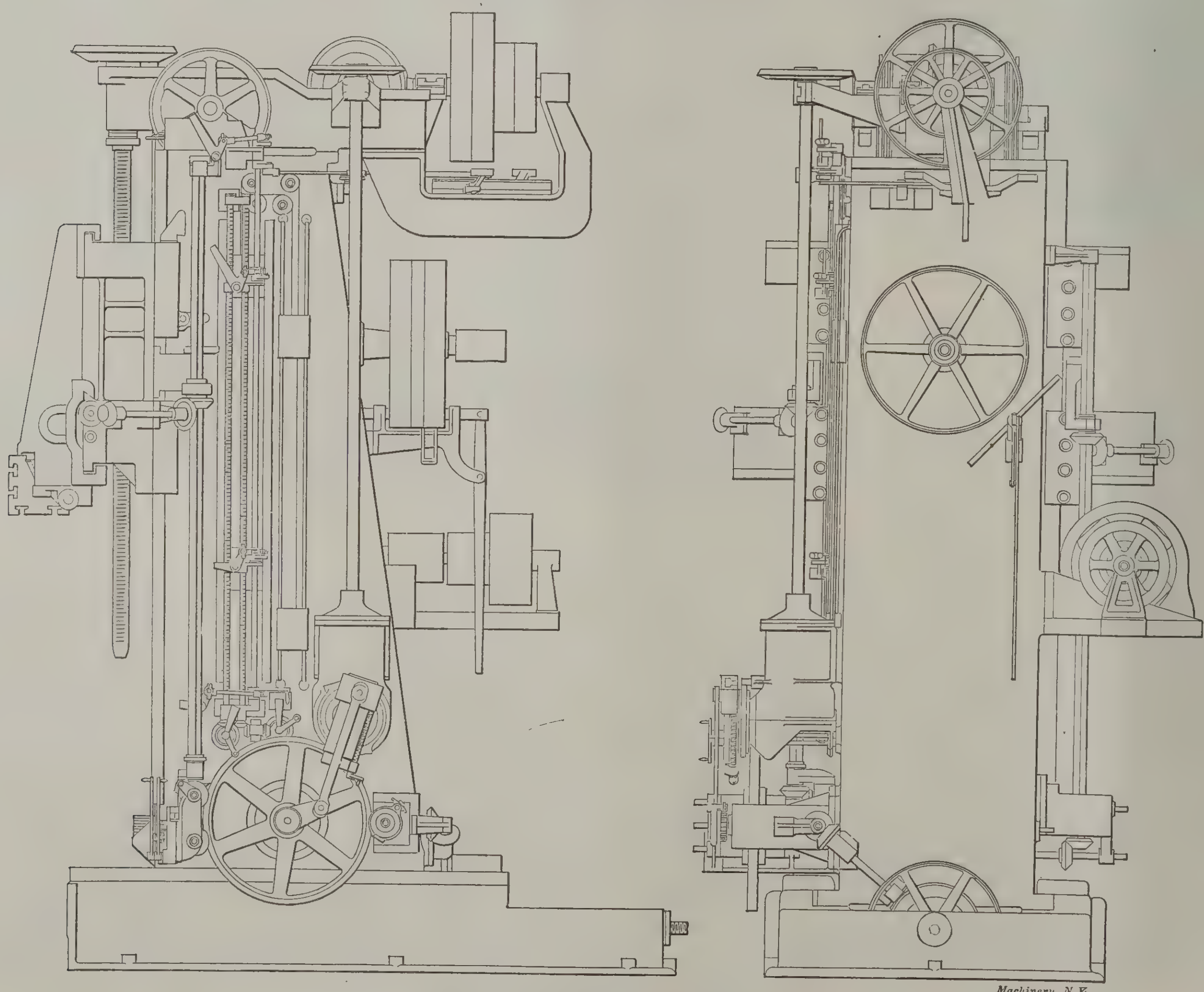


Fig. 5. Side and Rear View of Slotter.

hours, same requiring ten furnaces. We are exceedingly particular about the heat treatment, as much so as we are in the heat treatment of tool steel when tempering.

The furnace is an important factor. An oil or gas furnace to work successfully should be so constructed as to secure proper mixture of gases, a thorough and even combustion in every part of the furnace. The furnace should be constructed with roof arched throughout its entire length in order that the heat may be reflected directly and uniformly upon the boxes. The passage to the chimney is formed underneath the hearth, causing a down draft, the action being to throw the heat down upon the boxes. There are six flues, separated from each other at the end farthest from the fire place. These flues run parallel toward the fireplace or cumbustion chamber where they are connected downward with the main flue under ground, thence into the chimney.

It will be seen that this arrangement of furnace insures as nearly as possible an even heat throughout every square inch of heating parts of furnace. The furnace thus described can be heated with either oil or gas and has a capacity of eight boxes 12 inches wide, 20 inches long, and 8 inches high. The size of the box is of course governed by the size of the articles to be casehardened.

A quick method for casehardening consists in heating the material to be hardened to a red heat and submerging in a bath of molten cyanide of potash or potassium, leaving it in from one to five hours, according to bulk of material to be hardened. Cyanide of potassium gives off poisonous fumes, consequently the vessel containing it should be placed in a furnace with a draft. This method is dangerous for the operators and should, if used at all, be used in a very careful manner.

* * *

AN EXPOSITION OF SAFETY DEVICES.

The American Institute of Social Service will hold in New York City, in January next, an exposition of devices for safeguarding the lives and limbs of working men and women, and for preventing accidents under the ordinary conditions of life and labor to which the general public is exposed. This will be the first Exposition of the kind in this country, and it is surprising to note how far behind other nations we are in this respect. As far back as 1889 there was a German exposition for the prevention of accidents. In 1893 an exposition of this nature was held in Amsterdam, and since then there have been several similar expositions in continental Europe and in Canada. As an outgrowth of these national movements there have been organized several Museums of Security; one at Vienna in 1890, one at Amsterdam in 1893, one at Munich in 1900, one at Berlin in 1901, and one at Paris in 1905, and Russia, which we are inclined to look upon as semi-barbarous, has recently established a museum on a large scale in Moscow.

That these expositions and museums have been of real value to their respective countries is evinced by a comparative study of the number of accidents in Europe and in America, which shows that for the same number of men employed in a given trade, we have from two to nine times as many accidents as they have in European countries. It is estimated that the casualties of our industrial army in the United States are at least fifty per cent greater every year than the total number of killed and wounded during the late Russo-Japanese war. Such conditions can exist only through general ignorance of their reality, and it is for the purpose of educating the public to an appreciation of the actual situation and the means of its improvement that the Exposition of Safety Devices is to be held.

The interest of manufacturers generally is solicited, as well as that of organizations whose special function is to improve the conditions of labor, and a widespread response is looked for to this request for representation in the nature of photographs, descriptive drawings, models, and as far as possible, the devices themselves in actual operation. Following are some of the groups of exhibits:

Section 1.—Models, photographs and drawings of scaffolding, as well as the personal equipment of workers in building trades. 2. Protective devices for boilers, water gages, signal apparatus, boiler and pipe valves; also protective devices for electrical machinery and acetylene apparatus. 3. Protective devices for motors and power transmitters, devices for turning on power and shutting it off, belt connection, couplings, etc. 4. Fire protection and the prevention of explosions. 5. First aid to the injured. 6. Mining and quarrying; devices in use on stone crushing machinery, etc. Storing of explosives. 7. Metal industry; safety devices for metal-working machinery. 8. Textile industry: safety devices for looms, carding, etc. 9. Leather and paper industry: safety devices for paper cutting, stamping and moulding machinery. 10. Safety appliances for elevators and hoisting apparatus models. 11. Food products: safety appliances for kneading machines, rollers and cutters. 12. Personal equipment of workingmen: protective spectacles, respirators, suits, etc. 13. Workingmen's dwellings. 14 and 15. Housing: models, plans, photographs. 16. Ventilation. 17. Models, photographs and plans of toilets, dressing and living rooms, baths, etc. 18. Cooking: demonstration in heating food; models, plans, photographs. 19. Other social betterment institutions; reports of labor departments, industrial arbitration courts. 20. Agricultural machinery; safety appliances on same, demonstrated by models and views. 21. Lumber industry: safety devices for band and circular saws, planing machinery, etc., demonstrated by models. 22. Models, photographs and plans of workingmen's industrial betterment institutions of all kinds.

Requests for information regarding space should be made to Dr. William H. Tolman, Director, 287 Fourth Avenue, New York.

* * *

The remarkable extent to which the use of electricity for power purposes has been developed in the industrial plants of the country will be nowhere better exemplified than in the proposed electrical equipment of the new Gary, Indiana, plant, plans for the building of which were recently announced by the United States Steel Corporation. When completed, it is estimated that the plant will handle substantially 5,000,000 tons of ore a year, and produce annually approximately 2,500,000 tons of steel. There will be sixteen blast furnaces, of 450 tons daily capacity each, and eighty-four 60-ton basic open-hearth furnaces. The necessary electrical generating equipment capable of handling such an output is to have an initial capacity of 18,000 K.W., and will be so designed that extensions may be added indefinitely at one or both ends. The initial equipment will have a capacity of 18,000 K.W., 14,000 K.W. being in 2,000-K.W., 25-cycle, 2,300-volt units, and 4,000 K.W. in 2,000-K.W., 250-volt direct-current units. These generators will be built by the Allis-Chalmers Company, Milwaukee, and they will be direct coupled to nine Allis-Chalmers horizontal twin tandem gas engines. The power house building for the present is to be approximately 700 feet long with a span in the main building of 88 feet. An 18-foot extension under the same roof through the entire length of the structure, has been planned in order to provide the necessary room for high-tension switches. The power house will be located immediately adjacent to the blast furnace blowing engine houses, and between the blast furnaces and the open-hearth furnaces, most advantageously placed for fuel supply and for securing a minimum length of transmission lines to the various departments using electric power.

* * *

New York City, already noted for its skyscrapers, is to have another which will overtop them all and be the highest structure in America. It is the Singer Building at the corner of Liberty St. and Broadway. This building will consist of a fourteen-story building, and a tower 65 feet square and 612 feet high, containing forty-one floors, twenty-seven being above the level of the main structure. The total floor space of the building will be about 9½ acres and it is estimated that when fully occupied it will accommodate about 6,000 people. The height of the tower will be 57 feet greater than that of the Washington Monument and will be not far from two times the height of the main part of the Park Row Building, now the highest office building in the world.

* * *

When starting a nut a partial turn backwards will usually give notice when the thread of the screw and of the nut are at the right point for engagement.

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RAILWAY MACHINERY

A SPECIAL EDITION OF MACHINERY FOR THE RAILWAY SHOP, DEVOTED TO LOCOMOTIVE AND CAR EQUIPMENT AND MECHANICS.

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We solicit communications from practical men on subjects pertaining to railway machine shop practice, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

OCTOBER, 1906.

REDUCED COST OF TRANSPORTATION.

One of the encouraging features of the transportation business at the present time is the reduction in passenger rates by such railroads as the Pennsylvania, New York Central, Boston & Maine, and others. This has taken the form in most cases of mileage, 1,000 mileage book being sold at $20. We believe that the policy of cheaper passenger rates is one that will redound to the benefit of all concerned. The more people travel, the more business there will be done, and this means more freight to haul. Many roads are now running passenger trains which for the greater part of the year consist of cars containing but few passengers, and it costs practically as much to haul an empty train of cars as one fully loaded. The policy of reduced fares should tend to make the volume of transportation greater in the slack months. The use of mileage books good for an entire railroad system is a great convenience to the traveling public and should save a railroad company considerable expense in handling waiting crowds where a large number of tickets are usually sold. By all means let us have cheaper passenger rates and the general abolition of all forms of free transportation which might in any way be used as "graft."

* * *

TUNNELING THE HUDSON.

The north tube of the Pennsylvania Railroad twin tunnels under the North River had reached a stage that permitted a party of officials to make an inspection trip from Weehawken to New York, September 12. The headings of the south tube were joined a few days later. The work of boring the tunnels under the North River has progressed rapidly, the actual tunneling work for the first bore being completed about one year ahead of time. Work on both bores was started simultaneously on the Weehawken and New York sides, and the two headings of the north tube met in the river bed almost perfectly, it is claimed. When they were 125 feet apart work was stopped and exploring pipes were driven through the intervening mud so that the alignment, which depended solely upon external measurements, of course, could be corrected. It is alleged that so accurately had the measurements been taken and followed that the alignment was out only about 1/8 inch and the grade about 3/4 inch. Work was then resumed with the necessary correction, so that when the two tubes met the lack of alignment was only about 1-16 inch. The building of these two tubes under the North River is perhaps one of the greatest of engineering feats. It was thought some years ago that tunnels in soft mud such as is characteristic of the North River bed were practically impossible, but the improved methods devised within the past few years have solved the North River difficulties much more easily than was anticipated. The joining of Manhattan to the mainland by railroad tunnels is an accomplishment well worth the great cost, and it means much for improved transportation.

* * *

PROMPT FREIGHT DELIVERIES.

In all the agitation concerning railway rates, rebates, etc., little has been said about one feature of railroad transportation which is fully as important as any question of rates, and that is prompt freight deliveries. It is a lamentable fact that most freight shipments on our American railroads require altogether too long a time, and the worst of it is that the period is of uncertain length. Occasionally a consignee is surprised to receive a freight shipment in about half the usual time, but more frequently he is disappointed by having the time drag out days or even weeks beyond the usual time allowance. The August 15 issue of *American Industries* contains a scathing arraignment of the railroad freight deliveries by Messrs. Giles and Donnan. It is accompanied by tables showing the actual elapsed time required on shipments from Richmond, Va., to various points in the South during 1906. To make a long story short it appears that a freight shipment on the average covered only about 61.61 miles in twenty-four hours, or at the almost incredibly slow rate of 2.57 miles per hour. Compared with this rate of progress, canal packets drawn by horses are swift, the average distance being 144 miles in twenty-four hours, or 6 miles per hour. Of what use are powerful locomotives, improved shops, heavy bridges, stone ballast, etc., if the average time for hauling freight falls below that possible with a horse-drawn vehicle?

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AN "OLD-FASHIONED" CONCERN.

An interesting pamphlet has been received from the Baldwin Locomotive Works containing an account of the ceremonies at the unveiling of the statue of Matthias W. Baldwin, April 17, 1906. This statue stands facing the office building of the works at the intersection of Broad and Spring Garden Streets, Philadelphia, and carries an appropriate inscription. The fame of the Baldwin Locomotive Works extends to the uttermost corners of the earth and it is doubtless, in many respects, one of the most remarkable manufacturing enterprises in this country. Occupying a restricted area in the heart of Philadelphia it employs from 15,000 to 20,000 men and annually turns out more than 2,000 locomotives. A fact of the utmost significance is that upwards of fifty persons now employed in the works date their employment as apprentices back to Mr. Baldwin's time, and he died 40 years ago. It is gratifying in these days to be able to record that a large concern like this has pursued such a liberal policy with its employees. Some of the men who started with it in a humble way are to-day important officers in its management and have accumulated fortunes. It seems to be one of the few concerns in which the leading workers have reaped largely of the benefits of their work, being in a limited sense co-operative in its management.

* * *

GERMAN AIR-BRAKE TESTS.

Experiments made by the governmental railroads of Bavaria indicate the superiority of the new Westinghouse air brake over air brakes previously in use. The experimental train was composed of a locomotive with tender (118 tons) and four cars weighing 36.5 tons each. The results were noted at different speeds, and where the road was not level the result was transformed so as to give the figures for level road. The new Westinghouse air brake brought the train to a full stop in 31.5 seconds when running at a speed of 75 miles an hour, while the common air brake required 41.5 seconds under the same conditions and with the same air pressure. When running at the more moderate speed of 45 miles an hour, the figures were 15.5 and 20.5 seconds respectively. The *Zeitschrift des Vereines Deutscher Ingenieure*, where these results were published at length, adds that the experiments gave great satisfaction and that the new air break works nearly without jars or objectionable vibrations.

GERMAN MACHINE TOOL COMPETITION.

The enormous increase of German machine tool manufacture should not be underestimated by American machine tool builders. The fact that the Germans do not appear as actual competitors in this country on account of our protective tariff does not exclude the inference that they will be, and already are, the most resourceful of all our competitors in the foreign market. The export of German machine tools in 1905 was more than three times as great as in 1900. The import of American machine tools to Germany had during the same period decreased so that in 1904 the import was less than half, and in 1905 about 30 per cent less than the import in 1900. The decreased imports are so much more significant when considering that the German tariff on machine tools is very low, amounting to only five, or at most ten per cent *ad valorem.*

At a recent meeting of German machine tool builders in Dusseldorf the confidence in their increased prestige was plainly in evidence. While recognizing that only a few years back there existed an "American Danger" to the German machine tool industry, it was agreed upon that this danger was now a thing of the past, provided that the German manufacturers continued to follow the path outlined by their successful American competitors.

While there is no doubt but what American machine tool builders will manage to remain in the lead, it may be well to point out the progress made in Germany. There is one distinctive feature about all German machine tools which cannot be overlooked. They all prove that there was a definite knowledge of mechanical principles involved in their design. The ingenuity with which some problems have been solved is surprising, and the only serious objection to a great majority of German makes of machine tools is the lack of recognition of the requirements of the operator. Some, indeed, require far more skill to operate than can be expected of an ordinary machine hand, while others are often to the highest degree "unhandy" to run. To remove these obstacles will probably be the next move of our German brethren, and then their competition may be so keenly felt that we will commence to discard the "cheap labor" which has of late been complained of as taking possession of our drafting rooms, and once more return to the maxim that practical experience without knowledge of mechanical principles is equally inefficient as is theoretical knowledge void of practical common sense.

* * *

WILL THE AUTOMOBILE FOLLOW THE BICYCLE?

The rise and decline of the bicycle was a phenomenon well within the memory of most readers. The building of bicycles and tricycles began in England and the first machines imported into this country attracted much attention. The writer remembers one aged townsman who bought an English tricycle at a cost of $250. Its advent in the town (about twenty-five years ago) was a nine-days' wonder and it was considered of sufficient interest and novelty to warrant giving it a place of honor in the principal exhibition hall of the county fair. The owner had the right of way on the sidewalk of the town, where he could often be seen gravely propelling himself on sunny afternoons, kindling envy in the hearts of small and large boys alike. He had a wide plank walk laid at considerable expense around his large garden, where in dignified retirement he could take exercise runs without the annoyance of being so much on public exhibition. Within a few years after, bicycles were owned by thousands, and every city, town and hamlet had its quota. Century runs were the thing and holidays and Sundays were given up to bicycle riding by a large part of the population. To-day it might almost be said that the bicycle is again something of a curiosity. In many towns it is rarely seen on the streets and is mostly used by messenger boys and others in business. In short, its use for pleasure has been very largely abandoned.

The automobile has, in a sense, displaced the bicycle, and in view of the experience of the bicycle many are asking themselves if the same waxing and waning of popularity will not be its fate. It seems somewhat improbable that as a vehicle for mere pleasure it can long continue to have the great vogue that it now enjoys. The first cost of the higher powered machines and the succeeding expenses put them out of the reach of most men; many who are now enjoying an automobile have discounted the future in order to do so. The memory of the bicycle century runs is recalled on seeing an automobilist tearing through the country at railroad speed, going nowhere in particular and seeing nothing as he goes. This is to say the least unprofitable, and anything which yields no profit and little pleasure is bound to be ephemeral in its popularity. We have always believed that the larger use of the automobile is, or should be, as a commercial vehicle for handling goods that are now largely drawn on trucks, and for the general sober business of the day. Unless it can make good for such purposes we may see the automobile become one of the "has beens" in comparatively few years.

* * *

THE FLAT ON THE TOP OF SHARP V-THREADS.

While theoretically the sharp V-thread is not flatted on the top of the thread, it has, on account of practical reasons, become necessary to provide this kind of thread with a slightly flatted portion. In the first place, it is very difficult to produce a perfectly sharp edge on the top of the thread, and, in the case of a tap, the sharp edge would be very likely to be impaired in hardening, leaving the top of the thread less perfect than if provided with a slight, uniform flat. In the second place, the sharp edge would wear away very rapidly, both in the case of a tap and a screw, and as the wear could not be expected to be uniform, the ultimate result would be far less desirable than the one obtained by slightly flatting the top of the thread from the beginning.

For the reasons mentioned it has always been the practice of tap manufacturers to provide the top of the thread on V-thread taps with a slight flat. But as a standard outside diameter always had to be maintained, the diameter in the angle of the thread had to be increased. This has caused difficulties, inasmuch as there has been no established standard as to *how much* of a flat the thread ought to be provided with, and various manufacturers have each had their own practice in this particular. The result has been that the gages from one firm have not corresponded to the taps manufactured by another, and many customers, not familiar with the reasons for this confusion, have questioned the correct size of gages as well as taps. The question has been still more confusing on account of the fact that many manufacturers did not have even a certain standard for all taps manufactured by them, but working to their old-established gages, they often produced large taps with smaller flats on the top of the thread, proportionally, than the flats on smaller taps.

In order to overcome the difficulties arising from the facts mentioned, we understand that the tap manufacturers are endeavoring to establish a standard flat for the top of sharp V-threads. While, as far as we know, nothing has been definitely agreed upon as yet, there seem to be opinions favoring a flat equal to one-fifteenth of the pitch. This is a greater flat than has hitherto been employed by some leading tap makers. Some have used the same flat for the V-thread as is used for the Brigg's standard pipe tap thread, which, although theoretically rounded at top and bottom, is, in this country at least, made with a small flat on the top of the thread. The width of this flat is selected so as to give exactly the same angle diameter as is obtained when rounding the top of the thread in accordance with Brigg's original proposition. This flat is equal to about one-twenty-fifth of the pitch.

While the exact width of the flat is of minor importance, it will save much confusion, as well to manufacturers as to customers, if a standard is agreed upon, and the country is to be congratulated upon the fact that there is a strong movement toward adopting standards in all the different fields of industrial activity.

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The report of the United States Geological Survey gives the production of Portland cement for the year 1905 as 35,246,812 barrels, having a value of $33,245,867. This represents an increase of nearly 25 per cent over the output of 1904.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The extent to which industrial education is carried in Germany is most easily comprehended when we hear that the number of students at the ten higher institutions for technical education was 15,800 during the winter term of 1905-1906. As there is a still greater number of smaller colleges and trade schools, all of which are attended by large bodies of students, it is no wonder that at present men of good technical education have to accept very inferior positions as far as salary concerns; but the excellent system of technical and industrial education in vogue in Germany has undoubtedly been the most active cause in the present progress of the industries of that country.

Regarding the sale of machine tools in China, Consul-General William Martin, of Hankow, China, says that it is a waste of money to send catalogues to China in English, and, in fact, intimates that the use there of catalogues in any language is a waste of time and money. The Chinese will not buy that way; their purchases must be made from the man on the ground who has the goods to show. They are very suspicious and take nothing on faith. The Germans now have many men laying foundations in China for future trade, and the Japanese as well as the British are very active. The consul believes that China will eventually be a great field for the sale of foreign tools and manufactured goods of all kinds.

A writer in a textbook on standard metals for manual training schools says: "Copper is seldom used in the form of a casting for the reason that it has no special merit in any heavy form, but when combined with other metals its greater merit is apparent." This statement is not altogether exact. One very potent reason why copper is seldom used in the form of a casting is the difficulty of making pure copper castings free from blowholes. Molten copper has such an affinity for oxygen that its exposure to the air even during the short period of pouring into a mold is sufficient oftentimes to make the castings porous, and unless the molder is unusually expert, the chances are that his efforts to produce sound copper castings will be without avail.

According to *The Canadian Engineer*, the two electric locomotives which have been used to haul the trains through the Simplon tunnel have proved inadequate for the work. Each of these engines had two motors of 450 horse power, which could be urged up to 550 horse power. As to the cause for the failure of the engines there are two theories. One is that the engines, having a section of two-thirds of the sectional area of the tunnel itself, acted as pistons in a cylinder, and wasted a large portion of their power in compressing the air in front of them. Another theory is that the air, saturated with the moisture from hot springs which keep the tunnel walls at a temperature of 93 degrees, penetrated the insulation of the motors and caused an important leakage of the current.

We have received a reprint of an article, "The Submarine vs. The Submersible," by Mr. Simon Lake, published in the *Journal of the American Society of Naval Engineers*, May, 1906. This paper treates in an interesting manner of the relative stability of the submarine and submersible boats that have been built for naval purposes. It points out the weakness of the submarine type which depends upon angular change of the horizontal axis in order to rise or descend. Comparison with the submersible or Lake type is, of course, favorable to the latter, the reasons given being well worth reading. In fact the whole article is well worth reading by any one interested in the subject from a military standpoint, or for a study of the actions of bodies immersed in a liquid and dependent upon tnat liquid as a resisting medium for all movements.

The German government, always ready for experiments, has undertaken to ascertain the comparative value of a typewritten copy for legal documents as compared with a handwritten one. The object of the experiment was to find whether a typewritten document would stand the test of time equally well with one written with the best writing ink. It was found that a decided difference could be noticed according to what class of ribbons were used for the typewriter, but it was ascertained beyond doubt that by using the best ribbon obtainable a copy could be produced which would have the same lasting qualities as a handwritten one. It is of interest to note that while some German ribbons proved satisfactory, the American-made product proved to be of a higher quality in general. But we may be assured that the Germans will not rest from now on until their typewriter ribbons are prepared equally well with ours.

One of the most progressive of the independent principalities of Asia is the little kingdom of Siam on the Indo-Chinese Peninsula. In the principal city, Bankok, is a modern electric railway power plant, operated by the Siam Electricity Company, and equipped with reciprocating engines and generators. Because of the increased demand for power an additional unit has become necessary and a Curtis steam turbine has been ordered. This is a 500-kilowatt, 575-volt machine, built by the General Electric Company, Schenectady, N. Y. The boiler plant for this station is unique in that paddy husks are burned in place of coal. The fuel is brought down the river from the rice fields in flat-bottomed boats to the power house and unloaded directly into the boiler room by an elevator and belt conveyor, built by the Link Belt Company, Philadelphia, Pa., and operated by several direct-current motors. This method of using rice husks for fuel is an economic utilization of a waste product similar to the use of the crushed sugar cane, or bagasse, on sugar plantation in Cuba and other countries.

Consul Wm. Bardel writes from Bamberg that Engineer Balderauer, of Salzburg, has invented a balloon railroad, experiments with which are now being made in the mountains in the neighborhood of that German city. It consists of a captive balloon, which is fastened to a slide running along a single steel rail. The rail is fastened to the side of a steep mountain, which ordinary railroads could not climb, except through deep cuts and tunnels. The balloon is to float about 35 feet over the ground, and a heavy steel cable connects it with the rail. The conductor can, at will, make the balloon slide up and down the side of the mountain. For going up the motive power is furnished by hydrogen gas, while the descent is caused by loading up with water, which is poured into a tank at the upper end of the trip, and thus serves as ballast. Suspended from the balloon is a circular car with room for ten passengers. The cable goes from the bottom of the balloon through the center of the car to a regulator of speed, which is controlled by the conductor. The inventor of this railroad claims that his patent will force all incline cable roads out of existence. Of course!

The subject of denatured alcohol takes up a considerable part of consular report No. 2,662, it being devoted to the production, manufacture, distribution and consumption in Germany and France. The consumption in Germany of completely and partially denatured alcohol has increased from 25,429,118 gallons in 1901 to 36,943,869 gallons in 1905. Methods of denaturing and the ingredients used are referred to at some length. In France, the government has made considerable effort to stimulate and extend the production and use of alcohol for industrial purposes, but the results have not been altogether satisfactory. The ministers of commerce and agriculture organized a special exhibition and offered prizes for the most effective type of alcohol motors, both stationary and portable, for motor vehicles, alcohol lamps, stoves, etc. The result of this exhibition has been on the whole disappointing, the consumption for such purposes not having increased to

any important degree. It is claimed that the French motor car builders have not found alcohol fully successful, the vapor exploding more suddenly and powerfully than petroleum vapor, and the gases attack bright iron and steel so that it is somewhat difficult to keep cylinders, valves and pistons in order. A mixture of 20 to 30 per cent of benzine gives somewhat better results, but is open to the objection that alcohol and benzine do not volatilize at the same temperature, hence one ingredient of the mixture will be exhausted more rapidly than the other.

The technical schools have filled a want, and have done much good in certain branches of industry, but they assume too much when they undertake to give a young man a course in conservation of forces, statics and dynamics, graphic statics, strength of materials, mechanics, drawing, machine design, mechanical engineering and shop practice, all in the short space of four years. He is given a diploma, signifying he has nothing more to learn and is capable of taking the management of a factory. I had a young man as draftsman, who had taken an engineering course in one of the Boston technical schools. He carried a sample of work with him which he had made during his course in shop practice. It consisted of two pieces of cast iron about two inches square and one inch thick. One piece had a groove about three-eighths of an inch square cut across the face, the other piece had a corresponding projection across its face, together forming a tongue and groove. These pieces were accurately fitted together so that the tongue could slide from end to end and when reversed fit just as accurately. I asked the young man what tools he had to do the job with. He replied: hammer, chisel, file and scraper. I then asked him how long it had taken him to make the piece. He said that he had spoiled two or three pieces before he got them to fit, and that in all, he had probably spent three or four days upon the job. Any modern machine shop could duplicate those pieces with profit for 15 cents or 20 cents apiece. *Time and cost* are the main functions in productive science, and when these essential features are not included in the so-called shop practice, the true object of technology is lost.—*Extract from paper "Value of Technology" read by Mr. Thomas Hill before the Western Society Associated Engineers, July* 18, 1906.

The proposal to utilize metallic colloids for industrial and other purposes opens up at once an extraordinary field of speculation. A colloid, according to Dr. Kuzel, contains energy. "It may possibly be looked upon," to use his own words, "as a primary source of energy. The colloid condition is in fact a dynamical condition of matter, while the crystalline condition is the static condition." "One of the most striking properties of the colloidal condition," he goes on to say, "is that bodies, for instance, metals, which under ordinary conditions are not soluble in water, benzine, or benzol, etc., become at once soluble in these mediums without in any way losing the chemical nature when in colloidal from." Dr. Kuzel instances two colloidal forms of metals, one of which he calls "sols," the other "gels." The latter, according to him, have the property of gelatinizing, assuming the appearance and substance of albumen. In this form metals may be mixed together, forming any desired alloy in a soft or plastic condition. In this form, metals such as wolfram, molybdenum, uranium, tantalum, thorium, etc., may be utilized, according to the inventor, for, among other purposes, incandescent light-giving filaments; that is to say, using Dr. Kuzel's words in his English patents: "Of this plastic mass I form bodies in any known or suitable manner of the shape and size desired for the light-emitting bodies to be produced." A metal or combination of metals in gels, or colloid coagulant form, can be "squirted" in the fashion employed in making ordinary incandescent filaments, or in the manufacture of cordite. The plastic filaments thus produced are then heated to a white heat, when, according to the specification, they return to a crystalline state, "their diameter and specific resistance diminishing notably." Dr. Kuzel, it may be mentioned, has a large laboratory at his home in Austria, and has repeatedly demonstrated there his processes in colloids in a practical form.—*Times Engineering Supplement.*

THE NON-LUMINOUS ALCOHOL FLAME.

Among the points brought out in the investigation of the availability of alcohol as a fuel for the internal combustion engine is the advantage it derives from the non-luminous character of its flame. As is well known to any one who has ever seen alcohol burn, its flame is bluish and gives out little light, which means that it is almost entirely devoid of free carbon particles. It is these particles of incandescent solid matter which give to a flame the greater part of its heat radiating power. When gasoline and most other oils are burning, the flame, made luminous by carbon or soot, radiates heat to such a degree that it is not possible to approach near the conflagration and combustible surroundings are readily fired by pure radiation. Not only does this property of alcohol render the fuel a safer one in case of accidental ignition, but it has a favorable effect as well when used as a fuel in the cylinder of an engine. Since the flame has very slight radiating power less heat will be absorbed by the walls of the cylinder, and consequently much less will be taken up in the water jacket and carried away as lost heat, than is the case when gas or any form of petroleum is used.

POWER TRANSMISSION BY MEANS OF GAS.

In a paper read recently before the Society of Arts, London, on coal conservation, power transmission and smoke prevention, the author, H. A. Martin, as reported in the *Electrical Review*, suggests the possibility that gas may be found a more economical and convenient means of transmitting power over long distances than is electricity. This possibility is especially applicable to the case of London, which has no large hydraulic power near it to serve as an economical source of electricity, but has to depend instead on coal which is brought to it from the northern counties. Aside from the question of cost, the enormous volumes of smoke generated by the burning of this coal intensifies the fog which is one of the most serious problems that that city has to deal with. It is pointed out that gas could be generated from coal at the mines and transmitted under a pressure of about 500 pounds per square inch to the power centers, where it can be used for heating and in internal combustion engines. This high compression, which is the most costly and serious feature of the plan, is necessary, otherwise the cost of the large pipes which would be required for low pressure gas, would swamp the undertaking. This makes necessary a pressure reducing plant at the receiving station. Mr. Martin, to make the system as economical as possible, proposes a number of refinements by which sufficient savings may be effected to counterbalance the cost of transporting the gas, and stress is laid as well upon the by-products of the system—the production of fertilizing and other substances. The utilization of the cooling action of the expanding gases in refrigerating plants is also suggested. The plan would thus involve quite a complication of details, enough, perhaps, to render its success somewhat doubtful.

Power transmission by gas, however, it is considered, would solve some of the problems not solved up to the present time by electrical transmission. While all admit that no small motive power can compare with the electric motor, and that electric lamps are the best illuminating agents yet devised, yet when it comes to heating, the electric system is at a disadvantage. Electric heaters are perfectly effective, that is to say all the energy supplied to them is converted into heat, but the losses which have taken place before the energy reaches the heater are very great; while in the gas system all of the energy of the gas is converted into heat. In other words, we start with our energy in the form of heat which is obtained by burning the gas. In an electric system we must carry this through a number of transformations, one of which, that from heat into motion, is not very efficient. This objection applies only to electric energy generated from fuel; when obtained from other sources the transformation ratio is high and the cost depends mainly on the cost of the apparatus.

Mr. Martin suggests that the amount of coal consumed by coasting steamers, freight and switching engines, which now carry the fuel supply of London, is no inconsiderable factor in determining the most efficient means of transferring the

required energy from the mines to the metropolis. In the proposed gas pipe-line system, however, there happens to be a source of power already available in the heat of combustion from the gas producing apparatus. The gases leave the retort ovens at a very high temperature, the greater part of their heat being generally wasted, when, by means of suitably arranged boilers, they probably might be made to furnish all of the steam required to work the compressors.

SOME USES OF PURE MANGANESE AND ITS ALLOYS.

Mechanical World, August 10, 1906.

A good deal of information has recently been published regarding the uses of magnesium as a deoxidizer for obtaining sound casting of certain metals and alloys. It does not appear to be generally known that manganese can be used with even better results for most purposes; therefore, the following brief remarks are of interest:

With manganese it is necessary to use the purest metal obtainable. Manganese made by the Goldschmidt aluminothermic process has a purity of about 99 per cent, the balance being chiefly silicon; this manganese is free from carbon, and technically free from iron, a point which makes it of great benefit for special brass and other alloys.

Pure manganese is a very brittle metal, and resists atmospheric influences for an unlimited time; its fusing point is about 2,240 degrees F. Among its chief characteristics is the ease with which it alloys with copper, nickel, zinc, tin, aluminum and other metals.

Pure manganese may be added in any percentage to zinc-copper alloys, the result being a very considerable increase of strength and density, and often of elasticity; such alloys can also be more easily rolled. It should not, however, be added to tin-copper alloys containing more than about 2 to 3 per cent of tin, as the quality of the material is thereby deteriorated.

For nickel castings, manganese is used as a deoxidizer to produce a greater density. In this case about 2 per cent is added to the molten nickel. It is also used with beneficial results for making German silver. If about ½ per cent is added a bright color is produced similar to that of silver.

For aluminum alloys an addition of manganese copper, free from iron, which is made from pure metallic manganese and electrolytic copper, is preferable to zinc or nickel additions. About 3 per cent of manganese-copper will increase the strength of the material, give denser castings, and the alloy can be more easily machined.

Copper and bronze castings lose their brittleness if manganese is added instead of phosphorus; a material is thus obtained in which threads may be easily cut. Manganese-copper alloys are made to a large extent, containing from 2 to 12 per cent of manganese. Bronzes with 5 to 6 per cent of manganese have about the same color as copper and are very fire-resisting; they are used in the fire boxes of locomotives.

Manganese fulfills two purposes. First, it is a deoxidizing agent. In general, an addition of about ¼ per cent of manganese is sufficient. Compared with other deoxidizing agents, like phosphorus, manganese has the great advantage that if a surplus quantity is added, it improves the quality of the bath (the only exception being the case of bronze rich in tin); whereas, if too much phosphorus is added, it impairs the quality of the bath. In some cases about 1 per cent of manganese is added, in conjunction with phosphorus.

Second, it improves the quality of a great many metallic alloys. It combines easily with and has a great affinity for oxygen; moreover, since manganese oxide slags are very fluid and have a low specific gravity, they easily and quickly separate out of the baths. All castings with manganese alloys are to be made under exclusion of air as far as possible. It is, therefore, useful to sprinkle a small quantity of borax upon the surface of the metallic bath in the crucible. It then forms a thick plastic slag.

Manganese alloys with tin and zinc can also easily be prepared; generally, the following proportions are used: 20 parts of manganese to 80 of zinc, free from lead; 50 parts of manganese to 50 parts of tin, free from lead. The slag formed on the molten tin and zinc must, of course, be removed before adding the manganese, and the charge is kept heated for a couple of hours. With zinc it is important to take care that the temperature remains constant and does not increase. The loss in the preparation of 20 per cent manganese-zinc is only 4 per cent.

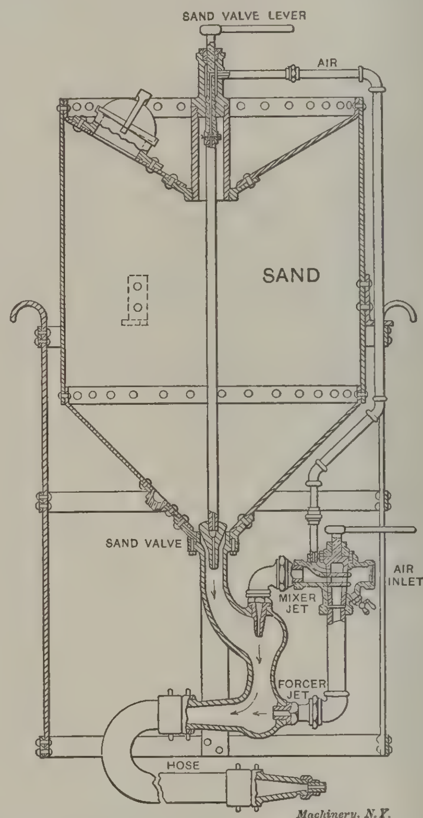
Manganese-copper free from iron is used in the nickel cupro manufacture of cartridge cases, etc., and does away with the annealing process.—W. B., Jr.

CLEANING CASTINGS BY THE SAND BLAST.

J. M. Betton, in *Compressed Air*.

This article on the sand blast and its use in cleaning castings, buildings, bridges, etc., covers practically the entire field of applicability of the sand blast for cleaning purposes, but in the following we have collected only such portions as are of service in foundry work.

In a sand blast apparatus, and especially in the injector sand blast, the injector principle is followed closely in first starting the flow of sand by creating a mild vacuum by means of a vertical jet through the sand valve, equivalent to the suction jet of the steam injector, mixing the sand and air by means of the second vertical or mixing jet, which also starts



Vertical Section through Sand Tank and Injector.

the combined current forward, and by augmenting the velocity of the current, using a horizontal or forcer jet, as well as by contracting the walls of the mixing chamber. In other words, the air supply is sub-divided and applied in such manner as to make its effort cumulative, thus producing a vigorous blast of thoroughly mixed sand and air, each grain of sand being projected upon the work with the highest possible velocity. By sub-dividing the air, the injector sand blast is able to obtain the same results with less consumption of air than the ordinary sand blast, in which the sand drops into a current of air and is blown onto the work. The general arrangement of an injector sand blast is shown in the cut, in which it will be seen that the first current of air to set the sand in motion passes in through the sand valve; the second or mixer jet enters a short distance below this, and the last or forcer jet sends the current of well-mixed air and sand into the nozzle pipe.

To obtain good results with a sand blast it is necessary to provide an ample supply of air. In the following table the

number of cubic feet of free air per minute required under different pressures for nozzles of different sizes is given:

Diameter of Nozzle in inches.	Air Gage Pressures in Pounds. 5	10	15	20	25	30
¼	14.4	21.8	26.7	30.8	34.5	40.
⅜	34.6	49.	60.	69.	77.	90.
½	61.6	87.	107.	123.	138.	161.
⅝	96.5	136.	167.	193.	216.	252.
¾	133.	196.	240.	277.	310.	362.
⅞	189.	267.	326.	378.	422.	493.

AIR PRESSURE REQUIRED.

For light work (stove castings, etc.)............	5 to 10 lbs.
For medium and heavy grade iron castings.......	15 to 20 lbs.
For steel castings..............................	30 to 75 lbs.
For cleaning buildings and steel structures....... (According to height.)	5 to 30 lbs.

The proper size of air tank for ordinary foundry work is about 30 inches diameter by 6 feet long, and it should be provided with a safety valve, a pressure gage and a blow-off, the latter near the bottom to remove water condensed from the air.

It is especially desirable that the air piping from receiver to sand blast be not less in diameter than the air connection of the sand blast. If the distance between the receiver and the sand blast is more than 75 feet, the pipe should be larger than the air connection of the sand blast, to allow for loss of pressure from friction. It is not that the sand blast will take all of this air; it can only take the amount which the nozzle will discharge under the working pressure (a ½-inch nozzle under 30 pounds' pressure will take 161 cubic feet of free air), but the best and most satisfactory results are only obtained by having this backing of air behind the jets.

The air piping should be protected from condensation if the lines be long, and if moisture or water shows in the air at its entrance into the sand blast, it is necessary that some means of removing this and drying the air be provided. This can be done by an "after cooler," or by means of one or more "U" loops introduced in the line of air piping. Drip cocks at the bottom of these loops will draw off the entrained water, or it may be removed by an ordinary bucket steam trap.

Water must be kept from the sand to insure proper working of the sand blast. If it enters the tank it will cause the sand to cake and arch over the sand valve, and the only remedy is to shut down, draw off the sand and start over again with dry sand.

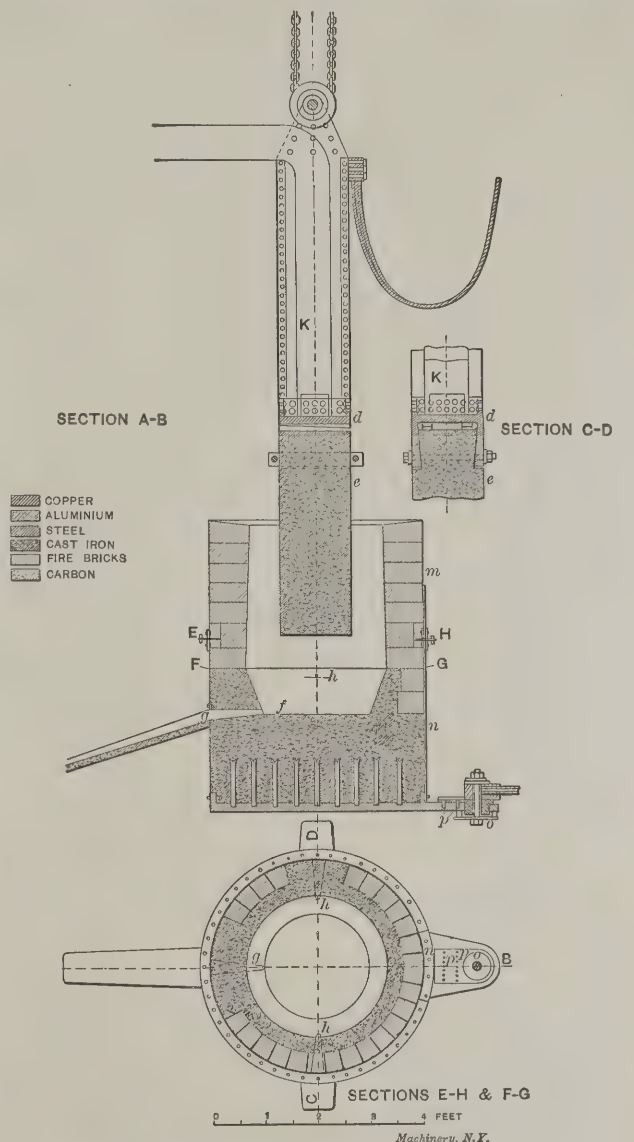
Dry sand, if left in the tank over night, will absorb moisture and may refuse to work the next day. The sand should be perfectly sharp, clean quartz or silica, sifted through a screen of proper mesh, and dried long enough beforehand to have it cold when used. If too warm it will generate steam in the tank, and if heated very hot it will crack and disintegrate. With a ¼-inch nozzle, the sand should be passed through a No. 8 mesh screen. With a ½-inch nozzle much coarser sand can be used, and the injector sand blast has been operated successfully with pebbles averaging ⅛ inch in diameter, using them again and again. These quickly rounded off their sharp edges, and their action upon the castings can be compared to that of peening them with an infinite number of small ball-peen hammers, cleaning them very thoroughly and giving a very good finish. A coarse sand or gravel will be found effective for general work in the foundry, especially for steel castings. W. B. Jr.

ELECTRIC SMELTING OF IRON ORE.

Under the auspices of the Canadian government quite a number of experiments have been made at Sault Ste. Marie, Ontario, on the smelting of iron ores by means of the electric furnace. These experiments have been conducted under the direction of Dr. Eugene Haanel, whose preliminary official report was recently made public. From the information given in this report it appears that the electrothermic process is likely to come into extensive use in the future, in the manufacture of high-grade steel and iron alloys, and possibly even in the production of pig iron.

The furnace used in the experiments is shown in vertical and horizontal sections. The dimensions of the furnace are as follows: Diameter of bottom of crucible, 2 feet; height of lower cone, 11 inches; height of upper cone, 33 inches; diameter at junction of the two cones, 32 inches, and at top of furnace 30 inches. The carbon electrode is 16 inches square and 6 feet long. The lower part of the furnace is made of carbon paste; the upper part of fire brick with a lining of carbon paste.

A 50-volt, 30-cycle transformer furnished the electrical energy. The principal ore experimented with was magnetite, and as it is to some extent a conductor of electricity, it was expected that considerable difficulty would be experienced in smelting it. It was thought that with the furnace used, as the electrode is immersed in the charge, current would leak laterally through the charge and thus prevent a sufficient amount from reaching the fusion zone to develop the high temperature required for fusion. With charcoal as a reducing agent no such difficulty was experienced; in fact, when crushed so as to pass through a ¾-inch mesh it worked as well as coke briquetted with clay.



Sections of Heroult's Electric Furnace for Iron Ore Reduction.

In one of the experiments the charge of the furnace consisted of: Ore, 400 pounds; charcoal, 125 pounds; limestone, 25 pounds; sand, 6 pounds. The data relating to this experiment is as follows:

Length of run, 65 hours 30 minutes.
Current voltage, 36.03.
Current, amperes, 4,987.
Electric horsepower, 221.34.
Ratio of weight of slag to that of iron, 0.41.
Pig iron produced, 11,989 pounds.
Pig iron per 1,000 electrical horsepower days, 9.92 tons.

An important result of the experiments was the fact that ores of high sulphur content, not containing manganese, can be made into pig iron containing only a few thousandths of a per cent of sulphur.

The ores treated, with the exception of the hematite and roasted pyrrhotite, contained a high percentage of magnesia, producing a very infusible slag. When the furnace had been running for some time this infusible material formed a scale around the crucible, the electric energy available not being sufficient to keep it in a molten condition. The crucible and lower part of the furnace were, therefore, partially filled up, preventing easy access of the charge to the reducing and melting zone. This slower feeding left the charcoal on top of the furnace exposed to the air a longer time, thus increasing the amount of charcoal required and decreasing the output. With a greater current than was available and consequent higher temperature, the formation of the scale would have been prevented, and the output correspondingly increased.

The consumption of the carbon electrode is small, as may be seen from the fact that 384 pounds were consumed in the production of 42,711 pounds of pig iron, which is at the rate of about 18 pounds per net ton of metal. The consumption of the electrode is greater for white iron than for gray.

According to Dr. Paul L. T. Heroult, a plant capable of producing 120 tons of pig iron per day would cost about $700,000 and the cost of making the iron would be $10.69. This estimate is based on the assumption that ore contains 55 per cent iron, and costs $1.50 per ton.

From the results obtained in the Sault Ste. Marie experiments, it would seem that the electric furnace stands a chance of competing with the present methods in the production of pig iron, at least under certain favorable conditions. For the manufacture of ferro alloys of high percentage, *Electrochemical and Metallurgical Industry* says that "the electric furnace now stands supreme, specially in the manufacture of those ferros in which a highly refractory oxide (like that of titanium) is to be reduced." For the manufacture of high-grade steel, the same authority says: "The electric furnace seems to be destined to gradually replace the crucible steel process. The advantages of the electric furnace are lower cost of operation, due to larger units and consequently smaller labor charge per ton of output and greater durability of the electric furnace. The cost of electric power is a comparatively small item in this case, and becomes almost insignificant if fluid steel is supplied from an open-hearth furnace or from a Bessemer converter to an electric furnace for refining. It is likely that steel which has been refined in the electric furnace at a small cost may be used in future to a much greater extent than is now possible with the high price of crucible steel."

W. B. Jr.

TECHNICAL CONCLUSIONS FROM THE GLIDDEN AUTOMOBILE TOUR.

The Horseless Age, August 1 and 8, 1906.

The Glidden contest is an annual event in the automobile world which is especially designed to test the economy and reliability of the contesting machines under severe touring conditions. The route of this year's race was about 1,200 miles in length, starting at Buffalo, N. Y., thence eastward across the State and northward to Montreal, and up the St. Lawrence River. Then the route took a southward turn again down through the White Mountains, winding up at Bretton Woods, N. H. This route was a severe one in many respects, including stretches of sandy and rough roads, and many exceedingly steep grades. Albert L. Clough contributes to the *Horseless Age* the main results of his observations made during the tour as to the strength and efficiency of the various parts of the automobile mechanism. We give them here in abstract:

One noticeable feature of this year's contest was that all the American cars are of practically the same type. This standardization of form makes it possible to speak quite generally of the technical merits and demerits of the contesting vehicles as a whole. The greatest chance of drawing comparisons is in considering the details of construction, which still show some diversity. One of the principal points of interest relates to the efficiency of the air-cooled car, five of which entered the contest. This air cooling of the vehicle engine of large power is a distinctly American proposition. The writer kept close watch of the performance of the air-cooled cars and found his previous judgment as to this question far more than substantiated. Of the five air-cooled cars that started from Buffalo, four finished at Bretton Woods, two making perfect scores. At no time have any of the air-cooled engines been noticed in a dangerously overheated condition, and they have not found the pace at all in excess of their capabilities, at least so far as the cooling question is concerned. American builders would do well to give more attention to this type of engine instead of following foreign models so closely as they have done.

The weakest part of the chassis has been demonstrated to be the running gear of the car. This is the salient technical conclusion to be drawn from the contest. It looks as if the engine of the average car possesses enough power to strain the supporting framework to the point of destruction in a few thousand miles of hard running over unimproved country roads, without being itself injured to any serious extent. In the matter of axles, for instance, this tour must have proved an eye-opener to many manufacturers as well as to the owners of the machines themselves. There are very few tubular front axles to be found upon the contesting vehicles which have not more or less of a permanent set, while most I-section axles are in as good condition as they were at the start. It is to be presumed that the tubular axle will now be finally discarded, except for use upon very cheap cars. Notwithstanding the use of the shock absorber, the spring must be characterized as one of the weakest parts of the car. The spring problem is a difficult one and has not as yet received the intelligent attention it demands. It would seem that certain manufacturers must either increase their spring lengths with a corresponding increase of sectional dimensions or else resort to some other form of spring than the half-elliptic, such as the platform type or the double elliptic type. This change may come about when the very low-hung body is seen to be no special desideratum. Is it certain that the list of special steels has been exhausted in a search for the best spring material? Possibly some such improvement as has lately been made in crankshaft material might be made in spring stock.

The brake problem is substantially solved. Some of the cars have required rather frequent brake adjustment, but the problem is merely one of providing more liberal wearing surface. The manufacturers of these cars will, without doubt, profit by the knowledge acquired in this tour. The same cannot be said with so much truth of the steering gears. They have been given severe usage over rocky, sandy and winding roads, and many of them have become quite loose, requiring considerable adjustment. The presence of back lash and the shocks communicated through imperfectly reversible steering mechanisms conspired to very much fatigue and lamed many of the operators.

Both chain and shaft drives have shown themselves able to do their work successfully under difficult conditions. There seems to be no reason to credit the assertion that is sometimes made that the shaft drive is inapplicable to heavy cars of high power.

Perhaps the most astonishing and welcome fact brought out is the great reliability and endurance of the engines. There have been practically no cases of serious mechanical engine troubles. There have been some few valve replacements, but very little tightening of bearings or anything of that sort. Not a few of the motors are too good for their cars and too powerful, capable of driving them to destruction in a short period. One can hardly refrain from being enthusiastic regarding the remarkable performances of these motors. There is no other thermal prime mover which approaches the vehicle engine in reliability, automaticity, and weight efficiency, considering the conditions under which it is used. During the whole tour there was substantially no trouble from faulty ignition. Clutches and change gears also seem to have been developed to a satisfactory degree of strength and reliability. As regards the ratio of speed reduction, however, the writer cannot help thinking that there are not a few high-grade cars which do not possess a large enough gear reduction upon the slowest speed to give them a safe margin of hill-climbing capability. Cars with three or four forward speeds employ the lower gear only at infrequent intervals. When its use becomes necessary, however, it should be so low as to over-

come all car resistances, up to the limit of traction; that is, it should be capable of slipping the rear wheels on good footing. Twenty per cent hills are always likely to be met with in country touring, and the purchaser of a costly touring car does not care to be stalled at such grades, as were not a few of the cars in this tour. A suspicion sometimes crosses the mind as to whether the modern car with the engine in the front part carries sufficient weight upon the driving wheels to meet unfavorable conditions.

To one who observed the slipping of driving wheels on one of the hills met with on the tour which presented a muddy surface, the question must have seemed a pertinent one. In this respect the discarded engine in the body was superior. Another difficulty met with on steep hills was the failure of the gravity gasoline system. On a 20 per cent grade with the tank under the front seat the head of gasoline may be lowered about eight inches, which may be enough, if the fuel supply is low, to reduce the head to nothing.

Besides the vindication of the capability of air cooling for protracted touring purposes, there is one other technical innovation which has had a successful try-out in this contest. I refer to the two-cycle engine. Though there was but a single car of this type in the run, which did not achieve a perfect score, it was penalized by a few points only, due to delays which it was understood were in no way connected with the application of the two-cycle principle. This car finished the tour apparently as well as did the majority of four-cycle cars with its propulsive mechanism in excellent condition. To all who looked forward to the demonstration of the fitness of valveless motors to automobile practice, this fact will be presently significant.

It was indeed a cruel fate which pursued the steam cars entered in this contest and led to the total destruction of two of them. Although these cars have been developed to a high pitch of reliability and efficiency in every other respect, there is always the hazard of the exposed flame to contend with. Gasoline cars were enormously in the majority in this tour, and at least two cars were overturned and several ditched, yet none of them met with destruction or damage by fire. All efforts to render the steam car as safe as the gasoline car in point of fire hazard must be made against heavy odds, and must be expected to result fruitlessly.

This tour has proven a wonderful demonstration of the reliability of the American motor car, being impressive on account of the very considerable number of them which completed the run without penalization, and on account of the large proportion of the entrants that finished. Of the three foreign-built cars in the tour, none escaped penalization and only one of them finished at all. While this fact may not be deeply significant, it will perhaps tend to strengthen the impression that it is folly to pay a fancy price for foreign cars when fully as serviceable American machines can be bought for far less money.

THE GAS TURBINE.

Dr. C. E. Lucke, *Engineering Magazine*, August, 1906.

Dr. Lucke gives a great deal of information on the gas turbine, based on actual experiments; this information is not encouraging to those who expect soon to see gas turbines in general use, but it will be of decided value to those who are or intend to be experimenters in this field, as it points out the almost insurmountable obstacles that stand in the way of success. The main features of the paper are given in what follows:

Inventors and engineers have experimented with complete gas turbines, with and without steam, as well as with the various elements going to make up the system, such as the compressor, the fire, the nozzle and the turbine wheel. Some of these experimental combinations have been made to run, but cannot be regarded as working machines merely because they run. To receive any consideration they must approach the steam or gas engine in efficiency, in reliability, life, space occupied, and other commercial features.

It is to be regretted that by far the most of the experimental results along these lines have been suppressed. The inventors or experimenters apparently hoped to achieve something wonderful, something which must not be disclosed to the world too soon, and so they have concealed their early work. Later, when the machine was built and operated, the failure was so humiliating that in some cases the experimenter was ashamed to publish his results, and in other cases it appears that large sums of money were spent, and those who spent it did not feel inclined to give results to the world, obtained at such large individual expense. If the results of every man who had experimented with this problem had been published, there would have been less experimenting. It is also extremely probable that if the results had been given freely to all who were interested in the problem, we would to-day be nearer success, or more certain of its impossibility.

In a paper published about a year ago, I pointed out one of the difficulties of obtaining a practical gas turbine—free expansion by means of the nozzle. That there were other difficulties was well known at that time, but it seems to me that the most basic difficulty was the one previously made prominent. It was found by experimenting with nozzles that the temperature drop in the nozzles between the place of no velocity and high pressure and the place of maximum velocity and low pressure was very small, and averaged about 12 per cent of what is theoretically possible. Since that time, the temperature drop in an actual turbine has been measured and compared with the theoretical pressure drop and the performance of the turbine operating with air has been measured. For convenience of operation the air was cold air, whereas in the practical gas turbine the air would be hot and possibly more or less mixed with steam, or possibly no air at all but carbon dioxide and nitrogen. In any event, the working fluid would be largely a perfect gas. The turbine used was a De Laval standard 30-horsepower machine intended for steam at 110 pounds pressure and having six nozzles. The turbine wheel runs at 20,000 revolutions per minute, and the power shaft 2,000 revolutions.

With each type of nozzle three different initial pressures were used, each with a different number of nozzles. Readings were taken of the temperature of the air entering the turbine and the temperature of the air in the exhaust chamber, with the corresponding pressures. This turbine was fitted for six nozzles in all, grouped in three pairs of two each. These nozzles were all designed for 110 pounds initial pressure at three different back pressures—atmospheric, 25.5 inches vacuum and 26.3 inches vacuum.

In the best results the figures are as follows: Initial temperature and pressure, respectively, 98 degrees and 85 pounds; final temperature and pressure 58 degrees and 0.03 pound; theoretical temperature, 123 degrees; range of temperature observed, 40 degrees; theoretical drop, 221 degrees; per cent of theoretical realized, 18.1. In the poorest result the temperature dropped 8 degrees, from 90 degrees to 82 degrees, while theoretically it should have dropped 188 degrees, the pressure drop being from 48 pounds to 0.12 pound. The per cent of the theoretical realized in this case was only 4.3. From this it appears that the temperature drop varies between 4 and 18 per cent of the theoretical drop. These results were determined with respect to speed also, which varied from 520 to 1,920 revolutions per minute.

The experiments fully confirm those previously reported and the conclusions drawn from them, that the temperature drop in free expansion with such nozzles as have been used indicates very small conversion of heat into work. Investigations by the author among men who have worked with compressed air and with jets and nozzles has failed to develop a single case where there occurs a substantial cooling of perfect gases by free expansion. One man is probably better fitted to express an opinion than any other, by reason of his life work—Dr. Ernest Körting, inventor for many years of jet apparatus of all sorts, and of gas engines and producers. After a life spent in such work with signal success, he sets it down as a fact that he has never noted a single case of efficient expansion of gases, as shown by temperature drop.

To secure some idea of the attitude of other engineers toward this gas engine situation, I addressed the following series of questions to a number of men whose opinions seem to be desirable:

a. Do you consider that there is anything theoretically im-

possible in the production of a gas turbine, with or without the use of steam?

b. Do you consider that there is anything practically prohibitive in carrying out the necessary process to produce a gas turbine, using either perfect gas or a mixture of perfect gas and steam?

c. What do you consider are the prospects of overcoming such difficulties as exist?

d. Do you consider that there is anything theoretically or practically difficult in the compressor part of the system?

e. In the combustion chamber of the system?

f. In the control of hot gases alone or with steam?

g. In the nozzle part of the system?

h. In the turbine wheel part of the system?

i. In any other part of the system?

These men represent the steam turbine field, the gas engine field, and scientific men not identified with any particular field. The replies are given in the following:

Prof. R. C. Carpenter:

"Respecting the future commercial success of the gas turbine, I would state that I have formed an opinion which is unfavorable, due to the extremely high temperature which the working parts must be subjected to.

"Quite a number of experiments respecting the gas turbine have been carried on in our laboratory during the past eight or ten years. I felt at first that the machine could be made a practical success, but latterly I have concluded that the practical difficulties were almost insurmountable.

"In my opinion there is nothing in fault with the theory of a gas turbine without the use of steam, but I do not believe that there is any immediate prospect of securing metals which will stand the high temperature required for the nozzles and buckets.

"Respecting the use of a combined gas and steam turbine, I have at the present time no definite or positive information which will enable me to express an opinion as to its future practicability. I think, however, that a turbine working on such a combination might have a fighting chance of succeeding."

Prof. Sidney A. Reeve:

"*a.* No.

"*b.* At present, yes.

"*c.* The prospects are excellent. The gas turbine is a new problem. The devices already standard in engineering practice were developed to meet earlier conditions. The conditions of the new problem are different. The usual period for the experimental development of a solution of the problem of building old devices along new lines is all that intervenes between the present and a practicable gas turbine.

"*d.* Theoretically, no. Practically, yes. The compressor is the only unsolved and difficult part of the problem.

"*e.* No, either theoretically or practically.

"*f.* With permanent gases, yes. With steam, no.

"*g.* No.

"*h.* No.

"*i.* No."

Prof. William T. Magruder:

"*a.* I see nothing theoretically impossible in gas turbines, although I am not prepared to predict how economical they will be in the use of fuel and repairs in practice.

"*b.* I feel that the obtainable temperatures which are desired for maximum efficiency may cause great difficulty, unless a suitable porcelain can be obtained.

"*c.* I have faith enough to believe that the difficulties will be overcome.

"*d.* I am not prepared to say that the compression is absolutely necessary, and believe that the difficulties peculiar to the problem can be overcome. A motor-driven, 550-revolution, 3,000-pound pressure, four stage air compressor at 85 per cent pneumatic efficiency is the latest success in this line.

"*e.* Your work is an answer to this question.

"*f.* Without steam it is the most serious proposition.

"*g.* Cannot say. Would try porcelain.

"I believe that a solution of the problem will be effected, which, in its way, will be as novel as the steam turbine. I would, however, prefer not to make any prediction or statement at present."

Mr. F. E. Junge:

"*a.* No.

"*b.* No.

"*c.* Prospects are good if efficiency of proposed turbine is second consideration.

"*d.* Nothing.

"*e.* Yes; difficulty of cooling.

"*f.* Yes; thermal inefficiency when steam is generated by injecting water into combustion chamber before or during combustion.

"*g.* No, if properly designed.

"*h.* Yes, impossibility of cooling blades and finding proper material to stand high temperatures continuously.

"*i.* None but lack of interest in manufacturing circles and among investors."

Prof. Elihu Thompson in his reply says that the gas turbine is certainly a very complex problem, and he is not prepared to answer the questions put, definitely, at this time. He sees, however, no theoretical impossibility in the gas turbine, with or without steam, but considers the practical problems of the greatest difficulty, especially the compression problem. The construction and operation problems are certainly difficult, and considerable time will probably elapse before any thoroughly workable gas turbine is produced, and the problem of its competing with other machines is naturally somewhat doubtful.

W. L. R. Emmet, after a few preliminary remarks relative to the theory of the subject, concludes his answer as follows:

"Even when due allowance is made for these difficulties, theory would indicate that fair economy might be obtained from a gas turbine. The development of any practicable process of this kind involves a great amount of thought and labor, and all that I can say of this process is that it seems to afford a less attractive field for development than many others to which a competent engineer might devote his energies."

After a review of the whole situation, it appears that theoretically there is nothing impossible in the problem, and such difficulties as exist are purely practical but of no mean order of magnitude. So great are the difficulties encountered by those who have experimented, and so great are those that are foreseen by practical men, whose lives are devoted to overcoming difficulties, that those who are engaged in trying to perfect such a machine as this are warned of the certainty that their efforts will be fruitless for a long time at least, that much money will be spent with no tangible results, and that the practical gas turbine is a long way off. W. B. Jr.

CURRENT PRACTICE IN PETROL ENGINE DESIGN.

G. W. Rice, *Sibley Journal of Engineering*, June, 1906.

This paper is an abstract from a thesis by the author for the M. E. degree. Mr. Rice gives working formulas for the dimensions of the various parts of petrol engines, especially the light-weight type used in automobiles. These formulas are deduced from actual practice, as exemplified in the latest designs of such machines, and are of special value to designers. All the essential information is given in the following abridgment of the paper. The author says:

It is the object of this paper to derive rational machine design formulas for the different parts of a petrol engine with the constants of the formulas derived from practice. In May, 1905, an explanation of this project, together with data sheets, were mailed to 200 builders, and from these, data on about seventy-five engines were obtained. In order to get the maximum explosion pressure, which we need in finding the stresses in the engine parts, the assumption is made that the compression pressure is one-fourth of the maximum explosion pressure. This assumption is very nearly correct and is used throughout this article.

Ratio of Length to Diameter.

While in stationary gas engines running at slow speed, the stroke is about 1.5 times the bore for thermodynamic reasons, in high-speed petrol engines the consideration of piston speed outweighs the former and in some cases it is shorter.

$l =$ cylinder length in inches.

$D =$ diameter of cylinder in inches.

Values of l and D were plotted, giving 1.07 as mean value of "A" in formula $l = A\,D$.

The designer's formula is,

$$l = 1.07\,D.$$

$D =$ the cylinder bore.

$l =$ length of stroke.

R. P. M. $=$ revolutions per minute.

$C\,l =$ clearance as a fraction of piston displacement.

The equation for the maximum horsepower is a rational formula, the constant in it being based on the current practice of 1905 and 1906.

$$\text{D. H. P. per cylinder} = \frac{D^2 \times L \times \text{R. P. M.} \times (.48 + 0.1\,C\,l)}{14000.}$$

Thickness of Cylinder Wall.

This depends on the stress which can safely be allowed for continuous repetition. On account of the desire for lightness

and the stiffening action of the jacket wall, this stress is taken as high as possible; in fact, instead of allowing the usual constant for reboring, it was found on plotting the data from engines in actual practice that this constant had a negative value of ⅛ inch.

t = thickness of cylinder wall.

s = allowable stress per square inch.

p = maximum explosion pressure.

D = cylinder diameter.

The design formulas are then:

$$t = \frac{pD}{5300} - \frac{1}{8}'' \text{ (Light automobile practice).}$$

$$t = \frac{pD}{3700} - \frac{1}{8}'' \text{ (Medium weight practice).}$$

$$t = \frac{pD}{3200} - \frac{1}{8}'' \text{ (Heavy marine practice).}$$

$$t = \frac{D}{16} \quad \text{(Rough rule, not considering pressure).}$$

Thickness of Integral Cast Cylinder Heads.

The common form of head is that of a flattened ellipse. Liberal fillets should be used where the head joins the cylinder wall, and the head may be gradually reduced in thickness as you approach the center. Close to the cylinder wall $t = 0.005\, D \sqrt{p}$; at the center $t = p\, D \div 1.5\, s$.

Thickness of Jacket Wall.

This is made as thin as it can be cast in the foundry; in some cases it is deposited electrolytically of copper; in other cases the cylinder is cast without a jacket, turned up inside and out and a thin metal jacket of copper or brass applied. This latter practice has come to the front a great deal during the last year. In cylinders made in this manner you can be sure that the cylinder wall has a constant thickness, which is something which cannot be said of the ordinary type, it is also of a very light construction.

Length of Piston.

The normal pressure between piston and cylinder wall for any point in the piston stroke is equal to pressure on piston head divided by the ratio of connecting rod to crank length. By assuming an average clearance and different ratios of connecting rod to crank, it was found that the average pressure on the piston head when the connecting rod and crank were at right angles, giving the maximum normal pressure on the piston, was 0.23 times the maximum pressure. The design formulas are:

$$l = 0.0167\, p \frac{D}{c}.$$

$$l = 1.125\, D.$$

p = maximum pressure on piston in pounds per square inch.

c = ratio of the connecting rod to the crank.

l = length of the piston.

Thickness of Rear Wall of Piston.

t = thickness of unribbed rear wall of piston.

p = maximum pressure in pounds per square inch.

D = diameter of cylinder.

The designer's formula is

$$t = 0.0034 \sqrt{p} \times D.$$

By plotting between piston head thickness and cylinder diameter, we get the rough design formula: Allow 1-16-inch thickness per inch of cylinder diameter.

Dimensions of Piston Rings.

In the consideration of piston ring dimensions, the first proportion with which we are interested is the diameter to which the outside of the cast-iron ring is finished. This must be a diameter slightly greater than the bore of the cylinder so as to furnish a sufficient packing action to the piston. This diameter is the same for eccentric turned rings as for non-eccentric ones, and by plotting between ring diameter and cylinder diameter it was found that the ring was turned to 1.03 times the cylinder diameter.

Right here it might be well to say that due to the heat of the burning gases expanding the piston head, that end of the piston has to be made slightly smaller down to the first ring than the rest of the piston, this allowance is usually taken as 0.001 inch per inch diameter of cylinder.

For plain rings of constant thickness the width was found to be 0.07 of the cylinder diameter and the thickness of the ring to be 0.5 of the width. The number of rings used by different builders varies widely, the common practice being three at the head end of the piston and one, known as an oil ring, at the open end.

The designer's formulas are:

$$d = 1.03\, D, \quad w = 0.07\, D, \quad t = 0.5\, w.$$

Design of Wrist Pin.

The average pressure on the piston pin will be the same as on the crankpin, neglecting inertia effects.

p = maximum pressure in the cylinder.

d = diameter of wrist pin.

l = length of wrist pin.

D = cylinder diameter.

The designer's formulas are:

$$d\, l = 0.000445\, p\, D$$

$$l = 2\tfrac{1}{4}\, d$$

$$d\, l = \frac{0.7854\, \pi\, D^2}{7}$$

$$d = 0.225\, D$$

Crank Pin Design in Engines with Main Bearing Each Side of Crank Pin.

Below is given data on the ultimate strength of 15 crank shafts having an average ultimate strength of 95,000 pounds per square inch. (See July, 1905, *Horseless Age*.)

Autocar	85,000	Pierce	105,000	Columbia	90,000
Moline	90,000	Lozier	100,000	Covert	80,000
Packard	100,000	S. and M.	125,000	Acme	90,000
St. Louis	70,000	Pierce	105,000	Thomas	105,000
Nameless	85,000	Haynes	90,000	Welch	115,000

and the very latest practice is using steel of special mixture giving it greater hardness and a very high tensile strength.

The designer's formulas for this type of crank shafts—

$$d = \frac{D}{43.2} \sqrt{p} \text{ for diameter of pin.}$$

$$l = 1\,1/3\; d \text{ for length of pin.}$$

Crank Pin Design in Engine not having Main Bearing Each Side of Crank Pin.

Assuming that for this type of engine $d = 2$ inches on the average, approximately,

$$d = \frac{D}{36.5} \sqrt{p} + 0.9''.$$

$$l = 3.75\, d - 3.75''.$$

A general average of all cases shows that the diameter of crank pin $= \frac{D}{2.8}$. Again the general average shows that the projected area of the crank pin is 1/5 of the piston area.

Design of Main Bearings.

d = diameter of main bearing.

The length of main bearing per cylinder in four cylinder engines with five main bearings is 2.82 d.

The length of main bearing per cylinder in four cylinder engines with three main bearings is 1.54 d.

The length of main bearings per cylinder in two-cycle engines is 4.45 d. (This applies to one- and two-cylinder engines only.)

The relative lengths of these bearings, among themselves, varies with the cylinder arrangement—whether they are cast in pair, separately, etc. In all cases, the bearing at the flywheel or power end of the shaft is made longer than any of the others because the weight of the wheel rests almost directly on it and, therefore, the average total pressure is much greater than on the others.

The designer's formulas are—for length of journal—given above.

$$\text{Diameter} = 7.24 \sqrt[3]{\frac{\text{H. P. per cylinder}}{\text{R. P. M.}}}.$$

Crank Throws or Webs.

d = diameter of main bearing.
d' = diameter of crank pin.
h = depth of crank throws.
b = thickness of crank throws.
b' = thickness of crank throws on flywheel side.
b'' = thickness of long crank throws.

The designer's formulas are:

$$d^3 = b\,h^2$$
$$h = 2.6\,b$$
$$b' = 1.25\,b$$
$$h = 1.33\,d'$$
$$b'' = 1.25\,b'$$

Inertia Effects of Reciprocating Parts.

F = inertia effects in pounds per square inch of piston area.
W = weight of (piston + 2/3 connecting rod).
N = R. P. M.
r = one half stroke, in feet.
c = ratio of connecting rod to crank.
D = cylinder diameter, inches.
w = weight of reciprocating parts per square inch of piston area.

$$F = \frac{W \times N^2 \times r \times 0.00034}{0.7854\,D^2} \times \left(I + \frac{I}{c}\right)$$

Now by plotting we find that the weight of reciprocating parts is 0.55 pounds per square inch of piston, and the value of "c" is 4. We may then rewrite the above equation as follows:

$$F = 1.25\ (w \times N^2 \times r \times 0.00034).$$
$$= 1.25\ (0.55 \times N^2 \times r \times 0.00034)$$
$$= 0.0002435\ (N^2 \times r)$$

Giving us a simple equation for inertia effects of a given engine at a given speed.

Stress in Connecting Rod Bolts.

The stress in the bolts of the connecting rod is almost entirely due to the inertia pressures at the end of the stroke. This stress may be found from the preceding formula by plotting the maximum inertia pressures at the engines' rated speed with the reduced bolt area. That is the area at the bottom of the threads. The average ratio of thread area to bolt area is 0.65 for the sizes commonly used in automobile engine construction.

Flywheel Design.

In the design of a flywheel for an automobile engine we have a proposition entirely different from the design of a flywheel for any type of stationary engine. In the automobile the function of the flywheel is not to keep the engine speed constant, but to furnish a storage reservoir of energy sufficient to start the car under any working conditions or to keep the engine turning over when running at very low speed and under heavy load. Current practice does not help us as much as it might in this particular, for the weights of flywheel used for the same powered engine varies widely among the different builders. The weight depends, first upon the diameter, and this depends, to a large extent upon where the wheel has to be put; second, upon the weight of the loaded car, relative to the power of the engine. It also depends upon the gearing ratio of the car and other things relative to the car design.

By plotting between engine stroke and flywheel diameter, we find that the diameter varies from 4.9 to 2.9 times the engine stroke. The average value of flywheel diameter being 3.5 times the engine stroke.

Engine Weight.

Instead of comparing the engine weight with the horsepower, as is usually done, let us compare it with the cubic inches of piston displacement. By plotting between the weight of the complete engine and cylinder volume in cubic inches, we find:

$$W = 1.125\ V + 100.$$

On plotting between engine weight without flywheel and cubic inches of piston displacement, we find:

$$W = 1.125\ V.$$

This indicates that irrespective of the power of the engine, the builders have always used a flywheel of about 100 pounds weight.

By plotting between engine weight and horsepower, we find the average value to be 17.6 pounds per horsepower.

Diameter and Lift of Exhaust Valves.

D = cylinder diameter.
L = length of stroke.
N = R. P. M.
S = allowable speed of gas in feet per minute = 3,520.
d = diameter of exhaust valve.
h = lift of exhaust valve.

In high-speed engines the ring area open to gas passage, seems to be the all important item, and not the diameter of the valve itself. The tendency being to keep the valves large in diameter, and to make the lift as small as possible, 7/16 inch was the highest lift noted on about 80 engines, with cylinder sizes up to 7 × 9 inches, while the theoretical lift would be ¼ of the diameter of the valve. About 5/16 inch is a popular lift in this country, while the French use much lower lifts. These low valve lifts are used in order to get a quick closing valve and to prevent hammering of the cams on the valve push rods.

The designer's formula is:

$$D^2\ L\ N = 84{,}500\ d\ h.$$

Valve Thickness.

For the thickness of the exhaust and inlet valves the formula of Reuleaux may be used:

$$t = r\sqrt{\frac{p}{s}}$$

t = thickness.
r = radius of supporting circle.
p = maximum pressure in cylinder.
s = fiber stress.

Or as given by another designer this is modified to read:

$$t = 0.45\ d\sqrt{\frac{p}{s}}$$

The maximum normal pressure of the valve on its seat is given by several authorities as 900 pounds per square inch and when a conical seated valve is used the angle is usually taken between 45 and 70 degrees, which makes the effective lift of the valve equal to the real lift times the sine of the valve angle which may be approximated at 0.75. Diameter of valve stem is taken as 1/5 valve diameter.

Inlet Valve Design.

Most that has been said relative to the exhaust valve may be applied to the inlet valve. The valves themselves are very often made interchangeable, but they are usually given different lifts, that of the inlet valve being smaller. The designer's formula is:

$$D^2\ L\ N = d\ h \times 107{,}000.$$

Speed of Exhaust Gases through Pipe.

D = cylinder diameter in inches.
L = length of stroke.
N = R. P. M.
S = allowable speed of gas in feet per minute = 6,550.
a = area of exhaust pipe (nominal).

The designer's formula is:

$$a = \frac{D^2\ L\ N}{50{,}000}.$$

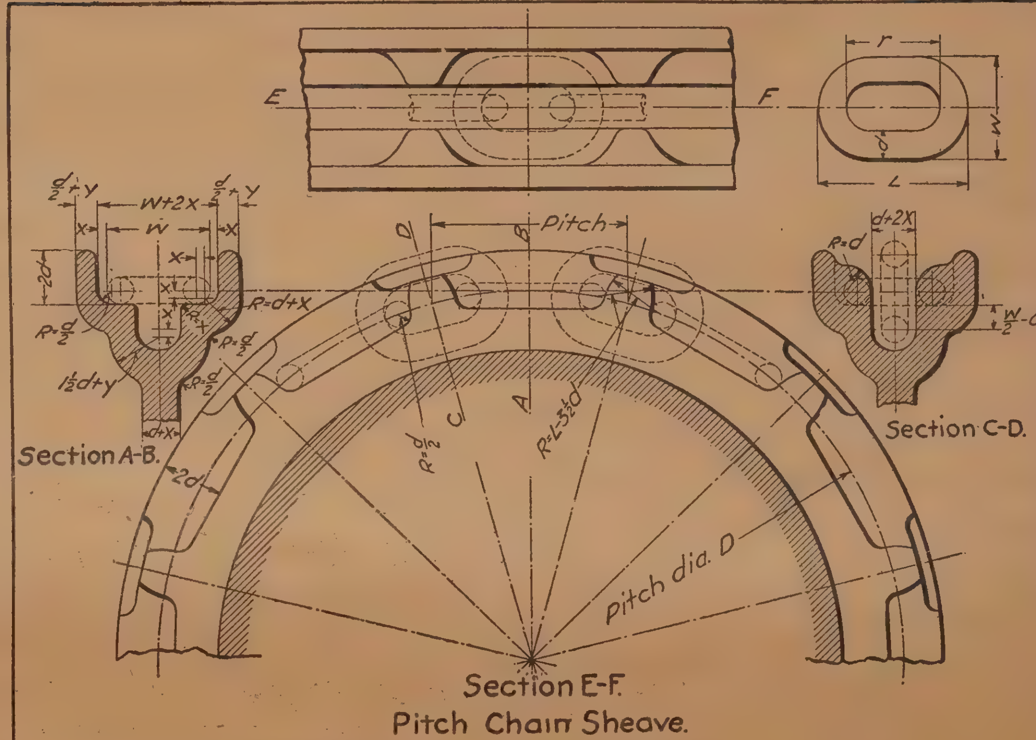
Speed of Gases through Inlet Pipe.

The designer's formula is:

$$a = \frac{D^2\ L\ N}{80{,}000}.$$

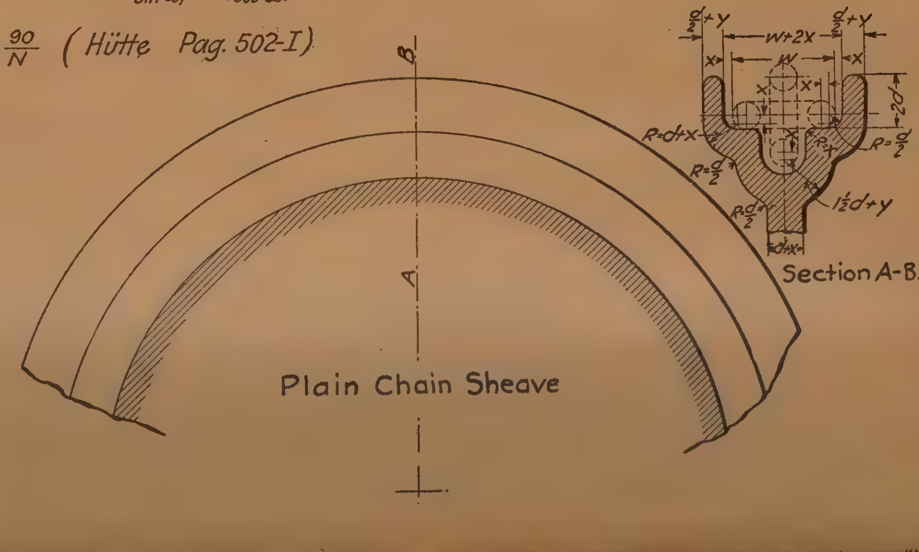
S = 10,000 feet per minute.

SPROCKET WHEELS FOR ORDINARY LINK CHAINS.—I.



Formula $D = \sqrt{\left(\frac{r}{\sin\alpha}\right)^2 + \left(\frac{d}{\cos\alpha}\right)^2}$

$\alpha^\circ = \frac{90}{N}$ (Hütte Pag. 502-I)



SPROCKET WHEELS FOR ORDINARY LINK CHAINS.—II.

No of Teeth=N=			5	6	7	8	9	10	11	12	13	14	15	16	17		
Angle α°=			18°0'	15°0'	12°51.4'	11°15'	10°0'	9°0'	8°10.9'	7°30'	6°55.4'	6°25.7'	6°0'	5°37.5'	5°17.64'		
d=size of chain	L=length of link	W=width of link	D= Pitch Diameter													X	Y
3/16"	1 3/8"	13/16"	3.24	3.87	4.50	5.13	5.76	6.40	7.03	7.66	8.29	8.93	9.57	10.20	10.84	1/16"	3/32"
1/4"	1 1/2"	1"	3.25	3.87	4.50	5.13	5.76	6.40	7.03	7.66	8.29	8.93	9.57	10.20	10.84	3/32"	3/32"
5/16"	1 3/4"	1 3/16"	3.65	4.35	5.06	5.77	6.48	7.18	7.91	8.62	9.33	10.05	10.76	11.47	12.19	3/32"	3/32"
3/8"	2"	1 3/8"	4.06	4.85	5.63	6.42	7.21	8.00	8.79	9.59	10.38	11.17	11.96	12.76	13.56	3/32"	3/32"
7/16"	2 1/4"	1 9/16"	4.49	5.31	6.18	7.06	7.74	8.79	9.67	10.53	11.41	12.28	13.16	14.03	14.90	3/32"	3/32"
1/2"	2 1/2"	1 3/4"	4.86	5.80	6.76	7.71	8.65	9.61	10.55	11.49	12.45	13.40	14.35	15.30	16.26	3/32"	1/16"
9/16"	2 7/8"	1 15/16"	5.69	6.79	7.88	8.97	10.08	11.19	12.30	13.41	14.52	15.63	16.74	17.85	18.97	1/8"	1/16"
5/8"	3 1/4"	2 1/8"	6.51	7.75	9.01	10.27	11.53	12.80	14.07	15.33	16.60	17.90	19.14	20.41	21.68	1/8"	1/16"
11/16"	3 1/2"	2 5/16"	6.91	8.25	9.58	10.91	12.26	13.61	14.95	16.29	17.65	18.99	20.34	21.69	23.04	1/8"	1/16"
3/4"	3 3/4"	2 1/2"	7.32	8.73	10.14	11.56	12.98	14.40	15.83	17.26	18.68	20.06	21.54	22.97	24.40	1/8"	1/16"
13/16"	4"	2 11/16"	7.73	9.21	10.71	12.20	13.72	15.21	16.71	18.20	19.72	21.23	22.74	24.24	25.75	1/8"	1/16"
7/8"	4 1/4"	3"	8.17	9.70	11.27	12.85	14.43	16.01	17.55	19.17	20.76	22.35	23.93	25.52	27.11	1/8"	1/16"
15/16"	4 1/2"	3 1/4"	8.55	10.19	11.84	13.50	15.15	16.81	18.47	20.13	21.80	23.46	25.13	26.80	28.47	1/8"	1/16"
1"	4 3/4"	3 1/2"	8.96	10.68	12.40	14.13	15.87	17.61	19.35	21.09	22.84	24.58	26.33	28.08	29.83	1/8"	
1 1/8"	5 1/2"	3 7/8"	10.58	12.61	14.66	16.71	18.76	20.81	22.87	24.93	26.99	29.05	31.11	33.18	35.25	1/8"	
1 1/4"	6"	4 1/4"	11.40	13.58	15.78	17.99	20.20	22.41	24.63	26.84	29.06	31.28	33.51	35.73	37.95	5/32"	
1 3/8"	6 1/2"	4 3/4"	12.22	14.56	16.91	19.27	21.64	24.01	26.39	28.75	31.14	33.52	35.90	38.37	40.67	5/32"	
1 1/2"	7 1/4"	5 1/4"	13.85	16.49	19.16	21.84	24.52	27.21	29.91	32.52	35.29	37.99	40.69			5/32"	
1 5/8"	7 7/8"	5 3/4"	15.06	17.95	20.85	23.77	26.62	29.61	32.54	35.47	38.41	41.34				5/32"	

STRENGTH OF GEAR TEETH.

W = Load Transmitted in Pounds.
S = Safe Fiber Stress.
W' = Load carried by a Gear 1 Pitch (Diametral), 1 Inch Face, Max. Fiber Stress 1000 Pounds.

f = Face in Inches
P = Diametral Pitch.

Formula, $W = \frac{S f W'}{1000 P}$

Speed of Teeth in Feet per Minute	100 or less	200	300	600	900	1200	1800	2400
S for Cast Iron	8,000	6,000	4,800	4,000	3,000	2,400	2,000	1,700
	10,000	7,500	6,000	5,000	3,750	3,000	2,500	2,125
	12,000	9,000	7,200	6,000	4,500	3,600	3,000	2,550
S for Steel	16,000	12,000	9,600	8,000	6,000	4,800	4,000	3,400
	20,000	15,000	12,000	10,000	7,500	6,000	5,000	4,250
	24,000	18,000	14,400	12,000	9,000	7,200	6,000	5,100

W' for 15° Involute Teeth

W'	No. of Teeth	W'	No. of Teeth
210	12	315	27
220	13	320	30
225	14	325	34
235	15	335	38
240	16	340	43
250	17	350	50
260	18	360	60
275	19	365	75
280	20	370	100
290	21	375	150
295	23	385	300
305	25	390	Rack

The higher values of S are close to the ultimate strength of Cast Iron, and are permissible only where the gears are not subject to shock.

SPROCKET WHEELS FOR ORDINARY LINK CHAINS.—III.

No. of Teeth = N =			18	19	20	21	22	23	24	25	26	27	28	29	30		
Angle $\alpha°$ =			5°0'	4°44.22'	4°30'	4°17.14'	4°5.45'	3°54.78'	3°45'	3°36'	3°27.69'	3°20'	3°12.85'	3°6.18'	3°0'		
d = size of chain	L = length of link	W = width of link	D = Pitch Diameter													X	Y
3/16"	1 3/8"	13/16"	11.47	12.11	12.75	13.38	14.02	14.66	15.29	15.93	16.56	17.20	17.84	18.47	19.11	1/16"	3/32"
1/4"	1 1/2"	1"	11.47	12.11	12.75	13.38	14.02	14.66	15.29	15.93	16.56	17.20	17.84	18.47	19.11	3/32"	3/32"
5/16"	1 3/4"	1 3/16"	12.91	13.62	14.34	15.05	15.77	16.49	17.20	17.92	18.62	19.34	20.06	20.80	21.50	3/32"	3/32"
3/8"	2"	1 3/8"	14.36	15.16	15.96	16.74	17.53	18.32	19.11	19.90	20.70	21.50	22.29	23.08	23.88	3/32"	3/32"
7/16"	2 1/4"	1 9/16"	15.78	16.65	17.53	18.40	19.27	20.15	21.02	21.90	22.77	23.65	24.52	25.40	26.27	3/32"	3/32"
1/2"	2 1/2"	1 3/4"	17.21	18.16	19.12	20.07	21.03	21.98	22.94	23.89	24.85	25.80	26.75	27.71	28.66	3/32"	1/16"
9/16"	2 7/8"	1 15/16"	20.08	21.19	22.30	23.42	24.53	25.64	26.76	27.87	28.98	30.10	31.21	32.32	33.43	1/8"	1/16"
5/8"	3 1/4"	2 1/8"	22.95	24.22	25.50	26.77	28.03	29.31	30.58	31.85	33.13	34.40	35.67	36.94	38.25	1/8"	1/16"
11/16"	3 1/2"	2 5/16"	24.34	25.73	27.09	28.44	29.79	31.14	32.49	33.84	35.20	36.55	37.90	39.25	40.60	1/8"	1/16"
3/4"	3 3/4"	2 1/2"	25.83	27.26	28.69	30.12	31.55	32.97	34.41	35.84	37.27	38.70	40.04			1/8"	1/16"
13/16"	4"	2 11/16"	27.26	28.77	30.28	31.79	33.30	34.81	36.32	37.83	39.34	40.85				1/8"	1/16"
7/8"	4 1/4"	3"	28.70	30.29	31.88	33.46	35.04	36.63	38.23	39.82	41.41					1/8"	1/16"
15/16"	4 1/2"	3 1/4"	30.14	31.80	33.46	35.13	36.83	38.48	40.15							1/8"	1/16"
1"	4 3/4"	3 1/2"	31.57	33.31	35.06	36.81	38.56	40.30								1/8"	
1 1/8"	5 1/2"	3 7/8"	37.32	39.38	41.45											1/8"	
1 1/4"	6"	4 1/4"	40.18													5/32"	
1 3/8"	6 1/2"	4 3/4"														5/32"	
1 1/2"	7 1/4"	5 1/4"														5/32"	
1 5/8"	7 7/8"	5 3/4"														5/32"	

Two-cycle Port Design.

The design of ports for two-cycle engines depends upon two important factors. First the height of the port determines the valve timing of the engine, and this timing must be arranged to give the proper results when the engine is running at slow speed. Next, the ports must be extended around the cylinder until a sufficient area is obtained to give the required engine speed. The two points then to consider are valve timing, and limiting gas velocities. This valve timing is very nearly constant for all the engines, the average values being 88 degrees for the inlet ports and 110 degrees for the exhaust ports. The velocity of the gases through the ports was found by assuming full port opening from the time the port began to open to the time it closes. The exhaust gas velocity was found to be quite constant at about 7,500 feet per minute. The inlet gas velocity varied with the crank case pressure, but as this pressure is either about 4 or 8 pounds, we find two values for inlet gas velocity. The gas velocity corresponding to 4 pounds is 12,000 foot-minutes, while that corresponding to 8 pounds is 24,000 foot-minutes.

Compression Pressure and Clearance.

Theoretically the compression of an engine depends upon the clearance, and from theory we can compute the compression of any engine of which we know the clearance volume. In practice we never get a full cylinder of explosive mixture, and the percentage which we do get depends upon the engine speed, the amount the engine is cooled, the temperature of entering charge, and the make of carburetor. The compression pressure varies directly as the square root of the R. P. M. and inversely as the square of the diameter of cylinder and inversely as the clearance to the 4/3 power.

A curve plotted between compression pressure and

$\sqrt{\frac{\text{R. P. M.}}{D^2 \times Cl^{\frac{4}{3}}}}$ gives $\sqrt{\frac{\text{R. P. M.}}{D^2 \times Cl^{\frac{4}{3}}}} = \frac{1}{2.25}$ compression absolute + 15.

W. B. Jr.

DENATURED ALCOHOL.

Consular Report No. 2666.

The strongest alcohol of commerce in the United States is usually 95 per cent alcohol and the price varies from $2.30 to $2.50 per gallon, showing that the greater part of the cost is due to the revenue levied by the government. The greater part of the 60,000,000 gallons of alcohol consumed in the United States is used in the manufacture of whisky and other beverages. The revenue tax prevents the use of alcohol to any great extent in the industries of the country. The bill passed at the last Congress, designed to promote the use of untaxed alcohol in the arts and as fuel, takes effect January 1, 1907. The first effect of free alcohol will be, it is said, to supplant the 12,000,000 gallons of wood alcohol which are used in the manufacture of paints, varnishes, shellacs, and other purposes. Another use that is expected of denatured alcohol is in the manufacture of certain products, such as dyestuffs and chemicals, which cannot now be manufactured commercially in this country because of the high cost of alcohol, and which are imported largely from Europe. A very rapid development of the industry of manufacturing chemicals as a result of free alcohol is looked for. In the production of alcohol there is always formed as a by-product a certain amount of fusel oil, which is very useful in manufacturing lacquers which are used on metallic substances, fine hardware, gas fixtures, and similar articles. The industries manufacturing these wares will undoubtedly receive a great stimulus as a result of cheaper fusel oil caused by the increased production of alcohol.

The use of denatured alcohol as a fuel has yet to be fully developed. Although alcohol has only about half the heating power of kerosene or gasoline, gallon for gallon, yet it has many valuable properties which may enable it to compete successfully in spite of its lower fuel value. In the first place it is very much safer. Alcohol has a tendency to simply heat the surrounding vapors and produce currents of hot gases which are not usually brought to high enough temperature to inflame articles at a distance. It can be easily diluted with water, and when it is diluted to more than one-half it ceases to be inflammable. Hence it may be readily extinguished, while burning gasoline, by floating on the water, simply spreads its flame when water is applied to it. Although alcohol has far less heating capacity than gasoline, the best experts believe that it will develop a much higher percentage of efficiency in motors than does gasoline. Since gasoline represents only about 2 per cent of the petroleum which is refined, its supply is limited and its price must constantly rise, in view of the enormous demand made for it for automobiles and gasoline engines in general. This will open a new opportunity for denatured alcohol. Industrial alcohol is now used in Germany in small portable lamps, which give it all the effects of a mantel burner heated by gas. The expense for alcohol is only about two-thirds as much per candlepower as is the cost of kerosene. Even at 25 or 30 cents a gallon, denatured alcohol can successfully compete with kerosene as a means of lighting.

* * *

SPROCKET WHEELS FOR ORDINARY LINK CHAINS.

In determining the pitch diameter of a sprocket wheel for use with the ordinary elliptical link chain, the geometrical problem involved is that of finding the diameter of a circle whose circumference can be spaced off into a given number of alternate long and short chords of given lengths. The dimensions of the chain and the number of teeth desired in the wheel form the conditions which determine the pitch diameter. As may be seen by referring to Plate I. in the Supplement, the form of sprocket wheel there detailed has one tooth for every two links. The dimensions which concern us in finding the pitch diameter of the sprocket wheel are: d, the diameter of the stock from which the link is made; and r, the pitch of the chain or length of the opening in the link. These dimensions are shown in the upper right-hand figure of Plate I. Given the number of teeth desired in the wheel, and these two dimensions, d and r, the formula for the pitch diameter, which is taken from a German handbook (*Hütte, Des Ingenieur Taschenbuch;* page 502—I.) is

$$D = \sqrt{\left(\frac{r}{\sin \alpha}\right)^2 + \left(\frac{d}{\cos \alpha}\right)^2}$$

in which $\alpha = \frac{90°}{N}$ when $N =$ the number of teeth. Referring to Fig. 1 below, which shows the impossible three-tooth sprocket for the sake of having the lines on a large scale, the derivation of the formula can readily be followed. The pitch circle passes, naturally, through o, the center of the circle

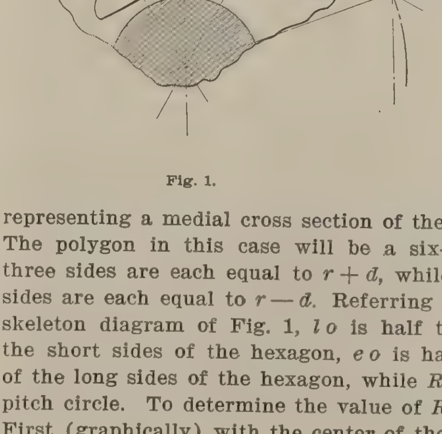


Fig. 1.

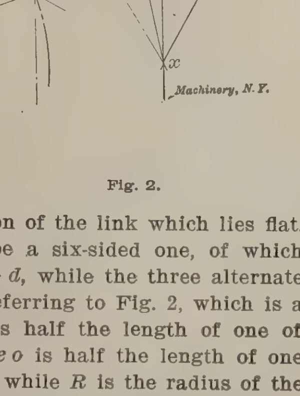


Fig. 2.

representing a medial cross section of the link which lies flat. The polygon in this case will be a six-sided one, of which three sides are each equal to $r + d$, while the three alternate sides are each equal to $r - d$. Referring to Fig. 2, which is a skeleton diagram of Fig. 1, $l\,o$ is half the length of one of the short sides of the hexagon, $e\,o$ is half the length of one of the long sides of the hexagon, while R is the radius of the pitch circle. To determine the value of R proceed as follows: First (graphically) with the center of the sprocket at x, draw

$g\,x$ and $f\,x$ at an angle of a degrees either side of vertical line $h\,x$. Construct the two right-angle triangles, $h\,g\,x$, and $h\,f\,x$, in which $h\,g$ and $h\,f$ each equal $r/2$ or half the pitch of the chain. To find the position of the center of the circular section of the flat link, draw the line $j\,o$ parallel with $g\,x$ at a distance of $d/2$ to the left of h. Draw also line $k\,o$ parallel to $l\,x$ at a distance $d/2$ to the left of h. Then, evidently, the point of intersection o will be the location of the center of the chain section, and R will be the radius of the pitch circle.

To solve this mathematically the problem may be analyzed as follows: In addition to lines previously drawn, draw $h\,m$ tangent to the circle representing the section of the chain, continue $l\,o$ to n and draw $o\,h$. We have first to prove that $\angle h\,o\,m = \angle h\,x\,g = a$. By construction $h\,f$ and $h\,g$ are portions of sides of a regular polygon of n sides, 6 in this case. The exterior angle of a regular polygon is equal to $360°/n$; therefore $\angle\ q\,h\,g$, the exterior angle of $\angle\ f\,h\,g, = 360°/n = 2\,a$. By construction, the sides of $\angle\ n\,o\,m$ and $\angle\ q\,h\,g$ are parallel, therefore the angles are equal; therefore $\angle\ n\,o\,m = 2\,a$. Since $p\,h$ and $m\,h$ are both tangent to the circle, it can be easily shown that line $o\,h$ bisects $\angle\ n\,o\,m$. Therefore $\angle h\,o\,m = a$. Since $o\,m = d/2$, $o\,h = \dfrac{d}{2 \times \cos a}$. Again, since $h\,g = r/2$, we have $h\,x = \dfrac{r}{2 \times \sin a}$. We know that $o\,h\,x$ is a right-angle triangle, since line $o\,h$ bisects the exterior angle of the regular polygon represented by lines $h\,f$ and $h\,g$; this polygon has its center at x. Triangle $o\,h\,x$ is therefore a right-angle triangle whose sides $o\,h$ and $h\,x$ we have just obtained, and from which we may readily obtain the value of R. This will evidently be expressed by the following equation:

$$R = \sqrt{\left(\frac{r}{2 \times \sin a}\right)^2 + \left(\frac{d}{2 \times \cos a}\right)^2}$$

Rearranging this equation to give the value of the pitch diameter directly we have

$$D = \sqrt{\left(\frac{r}{\sin a}\right)^2 + \left(\frac{d}{\cos a}\right)^2}$$

The tables in Plates II. and III. of the supplement give the pitch diameters of sprocket wheels for use with chains of various regular sizes from 3/16 inch stock to 1⅝ inch stock, for sprockets having 5 to 30 teeth. For instance, for an 18-tooth sprocket with a chain made from links of stock ½ inch in diameter the chain link being 2½ inches over all, the diameter will be 17.21. At the right of each of these tables are given two columns headed "x" and "y." These give constants to which reference is made in the dimensions on Plate I. These tables were contributed by Mr. F. Wackermann, chief draftsman of the Jones & Laughlin Steel Co., Pittsburg.

* * *

THE STRENGTH OF GEAR TEETH.

The formula known as "Lewis formula," given in Kent's handbook and in general use for determining the strength of gears is $W = S\,p\,f\,y$ in which

$W =$ the load transmitted.

$S =$ the safe working stress of the material, taken at 8,000 pounds for cast iron when the working speed is 100 feet or less per minute.

$p =$ the circular pitch.

$f =$ the face in inches.

$y =$ a factor taken from a table furnished whose value depends upon the shape of the tooth.

Our contributor, Mr. E. H. Fish, of the Worcester Polytechnic Institute, has prepared a tabulation of the quantities involved in this formula (see Supplement) which makes it somewhat more convenient for use than is the original form in which it was published. The formula proposed by Mr. Fish is

$$W = \frac{S\,f\,W'}{1{,}000\,P}$$

in which

$W =$ the load transmitted in pounds.

$S =$ safe fiber stress.

$W' =$ load carried by a gear 1 diametral pitch, 1 inch face at a maximum fiber stress of 1,000 pounds.

$f =$ face in inches.

$P =$ diametral pitch.

In obtaining the value for W', which is here given for 15-degree involute teeth only, the corresponding value of y in the table given in the handbook is multiplied by 1,000 to include the factor for maximum fiber stresses, and again by π to change the factor from one depending on circumferential pitch to one depending upon diametral pitch. This, carried through the scale from 12 teeth to the rack, gives the table shown in Plate IV. of the supplement; the table of stresses is self explanatory.

To show the use of this formula and the tables with it, let it be required to find the safe load which can be carried by a 4-pitch gear, 40 teeth, 2 inches wide, running with a peripheral speed of 600 feet per minute. This gear is made of steel and is supposed to be subject to considerable shock, so we will use the lower value given for that material in the table of stresses. With a surface speed of 600 feet per minute, the table gives 8,000 pounds as the safe fiber stress for a steel gear subject to shock. The value for the factor W' for 15-degree involute tooth in a gear having 40 teeth is found from the other table to be about 340. Substituting our known quantities in equation,

$$W = \frac{S\,f\,w'}{1{,}000\,P}$$

we have

$$W = \frac{8{,}000 \times 2 \times 340}{1{,}000 \times 2} = 2{,}720 \text{ pounds.}$$

* * *

FRESH WATER PONDS IN THE OCEAN.

A curious phenomenon often noticed in navigation is the existence of shallow ponds or lakes of fresh water on the surface of sea water. The cause of this isolation of fresh water is not fully known but is believed to be principally due to the melting of icebergs, and a subsequent lack of wind and currents to cause a mixture. A still more curious feature is that these strata of fresh water oppose considerably greater resistance to the progress of a vessel than does salt water. An explanation offered is that the passage of the vessel causes two sets of waves in the two strata of water—in short, relative movement which causes friction and retardation of motion. That such relative movement exists was proven experimentally. A large plate glass tank was filled to a certain depth with salt water and then a layer of fresh water was carefully poured on the surface so that two distinct layers of water were obtained. The salt water had been blackened with Chinese ink so that the junction of the two layers of water was clearly distinct. A boat model towed through the tank produced waves which were photographed and these photographs, it is claimed, showed conclusively that waves were set up at the boundary line between the two liquids. The experiment was also extended to actually demonstrate that a greater loss of headway does take place in a tank filled with layers of water of different density than in one filled with water of the same density throughout.

* * *

THE DRYING OF DAMP GOODS IN WET WEATHER.

During the rainy season, when the air is nearly saturated with moisture, drying takes place very slowly under ordinary circumstances, even if a steady current should pass the material to be dried; but as the capacity of air to absorb moisture varies with the temperature, it may be made more absorbent merely by heating it. For example, when the rain falls heavily in Bombay the temperature is frequently 82 degrees F., while the moisture is 90 per cent of saturation. This represents eleven grains of water per cubic foot. By heating the air to 110 degrees the saturation is reduced from 90 to 42 per cent, roughly, and the air is thus able to absorb as much again of water as it at first contained without being damper than its original condition. In this manner, by simply controlling the temperature of the current of air its drying power may be assured whatever the state of the weather may be.

THE MANUFACTURING ADVANTAGE.

TECUMSEH SWIFT.

When manufacturing businesses prosper and grow to the dimensions of some of our modern concerns they are very apt to lose some of their earlier advantages, and one of these is the closeness of touch, the mutual understanding and sympathy, the complete and automatic cooperation of the manufacturing and the selling ends. It is of the greatest importance that these two should grow up together and that in later years they should not be separated. Some of the most continuously prosperous concerns are those which have kept the manufacturing and the distributing branches of their businesses in the same location and in unsevered relationship. It is sufficient to mention the Brown & Sharpe Mfg. Co., the Warner & Swasey Co., the Eastman Kodak Co., and the National Cash Register Co. Surely each of these, and many others which might be mentioned, would have as much reason for locating their main business offices in New York City as most of these who are there, but it is easy to believe that any of these would be losers rather than gainers by such a change.

I, of course, am not writing with the slightest idea of changing the trend of business practice, but only in the way of suggesting how to make the best of it. It would be well for all of us here in the big New York offices and better for the companies with which we are connected if we were better acquainted with our shops and factories. If any of us here at the selling end, as we call it, ever run short of talking material and need filling up, the factory is the place to visit and to hang around. The true inwardness of all our product is revealed there, and the ability to tell the actual facts as to the construction and operation of all the machines we make is the surest way not only to the immediate selling of any specific thing but also to the building up of lasting business. Knowing that the product of our company has made its way upon its merits we can only hope to see it still progress along the same road. It is most essential that the fullest information concerning our output be widely spread abroad, and it can't be spread too thickly.

Not only should the public know as much as we can get it to know about the machines we build, but it would be well, also, for it to know about the magnificent and costly facilities we have for the building of them. The advantage which the large concern, when dominated by large ideas, has over the small competitor with small ideas is one of the most evident facts of modern manufacturing, and the calling of attention to it is legitimate business.

There is no occasion for hesitation about revealing things. Just as it has been demonstrated to pay best to tell the truth, the whole truth and nothing but the truth about the machines and tools of our entire list, I think it pays also to tell just as straight and just as fully and freely about our ways and means for making them. It may be that there are things at our factory which are more or less trade secrets and which it may be to our advantage not to let our competitors know about. If anyone knows what these things are he knows more than I do.

There are, however, many things at our factory which cannot possibly require any holding back or any reticence about, and which may be really among the strongest of talking material. It is possible for me to be very specific and precise here. Of course all the world knows our company as the largest builders of—say, gas engine pumps—in the world. The other day I was at the factory and I came along by a radial drill where a fellow was drilling a gas engine pump bedplate. I guess it was a 20 × 24-inch, and we all know that is a pretty big casting. It is about 15 feet long and 4 feet wide. The bedplate had been planed or milled—it might be revealing one of these trade secrets to tell how this was done—and the planing had left the casting entirely ready for the drilling. You should realize what an immense jig was used for this job. It was as big as the entire top of the bedplate and stiff and heavy enough to stand rough handling and to insure precision in use. It was a jig complete in every respect, with full provision for accurate setting and secure holding and with steel thimbles for all the holes to be drilled. One end of the jig was just planed to fit in between the planed jaws of the main bearings, and two feet resting on the planed flat surfaces of the crosshead slides were finished vertically on the outsides to just coincide with the planed outside edges of the slides. This located the jig laterally and other means equally simple and effective located it longitudinally, and then with screws set up horizontally in the different directions to keep it from sliding, and bolts at different points to hold it down it was all ready for the drilling. The casting was on rollers on the floor and the radial drill in combination with one or two movements of the casting lengthwise commanded all the holes.

This jig of course implies other jigs for the cylinders and the other pieces whose holes must absolutely coincide with those drilled in the bed; and this jig would be entirely worthless without the others, so that the entire outfit cost a lot of money. There is, of course, nothing about the jig requiring any special talent to design or any special skill to work. There are hundreds of men in hundreds of shops who could get up such a set of jigs for such a job, some of them perhaps not as good as this, some perhaps a little better, and there is absolutely no secret or novelty anywhere about the job.

The advantages resulting from the use of the jig in the processes of manufacture are more or less evident, although it takes some thought to get completely at the number and magnitude of them. The most evident and immediate advantage is in the saving of time. Suppose that the cylinders were laid out and drilled first, and the caps for the main bearings and the upper crosshead slides, and then that these all had to be carefully located on the bed "in the good old-fashioned way," to have the holes scratched through them on to the bedplate surface. Then these pieces would all have to be lifted off and the holes would then be prick-punched all around. Then there would be the careful starting of the drill for each hole, the coaxing of the centers this way or that and the not very accurate drilling of the holes after all.

When it came to the final setting and bolting on of the several pieces there would be more or less trouble and trimming of the holes and filing here and there, and the pieces finally fitted to one bed would never quite correctly fit any other. Throughout the job thus done "in the good old way," or even in the way of the small shop to-day, greater skill and care would be required all through, the job would not be nearly as good in any respect, and the cost of the work would be two or three times as great.

I don't know a thing about the figures in this case, but I suppose that when you can build gas engine pumps with cylinders as large as 20 × 24 inches, or other styles and sizes in lots of ten at a time, I am willing to believe that the entire jig outfit will pay for itself on the first batch, that the customers will get much better machines with full interchangeability, and that the company in all subsequent uses of the jigs will get a big interest on their far-seeing investment.

It is not merely, nor hardly at all, the capital of the big company which brings it this opportunity which it uses to its great advantage. It is the large sale of each established line of its product which alone warrants the expenditure. The small concern which must build its gas engine pumps in ones or twos, and which must be continually changing its product in some of its details in the struggle to keep up with the procession, cannot afford and cannot make it pay to rig up in this way, so that no matter how much they may know about the way to do it they must still "jog on the footpath way."

The seeing of the opportunities for economy with precision, and the constant and persistent taking advantage of them at the factory cannot be too highly commended, and the highest commendation lies in full appreciation, and what we fully appreciate we are likely to talk long and loud about, so the one thing to do is to insist upon it that all of our customers, especially those of the future, shall be completely informed as to how we do things, both for their good and for our own.

Whether machines shall be built in quantities which will warrant elaborate and costly preparation is, after all, in the hands of the selling force, for they must sell in commensurate quantities to sustain the production rate, and this is more likely to be realized and worked out to success the more the two ends of the business come in touch with each other.

CHARLES E. BILLINGS.

REPRESENTATIVE AMERICAN MECHANICS AND ENGINEERS.

Charles E. Billings was born in Weathersfield, Vt., December 5, 1835. In his early years he worked in the blacksmith shop of his father, and at the age of seventeen he went to work in the machine works of Robbins & Lawrence Co., Windsor, Vt., which was one of the pioneer machine-building concerns of this country. While serving his apprenticeship the company built a considerable number of milling, drilling, rifling and gun-stock turning machines for the Enfield Armory of Great Britain for the manufacture of the celebrated Enfield rifles. His foreman was Frederick Howe, of Windsor, Vt., who later became superintendent of the Providence Tool Co., and was later superintendent of the Brown & Sharpe Mfg. Co. The Robbins & Lawrence Co. also manufactured a firearm for the United States government known as the Harper's Ferry rifle, and Mr. Billings spent most of his time in the gun department. Here he first became acquainted with the primitive methods then employed for forging the various parts of guns, which he has described as follows (see MACHINERY, May, 1895): "A heavy cast-iron block called the 'sow block' with a suitable opening in the top for the lower die was held fast by keys and stock to guide the upper die, termed the 'jumper.' In the face of the die the forms to be forged were cut as at present, the power being applied by hand hammers and sledges wielded by the smith and his helpers, on the upper die, with the heated bar of metal held between them. Much time was spent in distributing the stock on the end of the bar of metal before the sledging took place in order to have the metal flow properly to fill the points of the die."

It was here, also, that Mr. Billings first saw a drop hammer, which was the forerunner of the present type. It was a crude affair with cast-iron base and uprights, the latter carrying a shaft at right angles on which was mounted a loose pulley for a belt and also a spool with flanges, for winding the belt. One end of the belt was attached to the spool and the other to a hammer. A clutch on the end of the shaft operated by a lever wound the belt on the spool and raised the hammer which was held at the height required by a dog on the side of the upright. This was tripped by a pedal when a blow was delivered.

Mr. Billings' experience in the gun department of the Robbins & Lawrence Co. naturally inclined him to this kind of work, and after becoming of age (1856) he went to Hartford, Conn., and entered the employ of Colt's Patent Firearms Mfg. Co. as a toolmaker and die-sinker in the forging department. Here he first saw a practical working drop hammer, being one designed by Elias K. Root, then superintendent of the works. In this way it happens that Samuel Colt is generally credited with being the pioneer in the manufacture and use of modern drop forgings or "machine blacksmithing," as they are sometimes called.

Mr. Billings remained at Colt's from 1856 until 1862, when he accepted a position with the gun factory of E. Remington & Sons, Ilion, N. Y., to introduce the manufacture of drop forgings. E. Remington & Sons had heretofore never used drop forgings in their gun work, but when the various governments required wrought frames for army and navy pistols it became necessary to use them. Mr. Billings superintended the drop forging plant and introduced his method of forging pistol frames, which was somewhat different from that used by Colt. During the four years he stayed at Ilion a saving of $50,000 was effected on government contracts by one simple feature of his method which saved about one pound of metal for each pistol frame, which had hitherto been rejected as waste. The iron being imported at the time was worth 20 cents per pound, hence the importance of avoiding all unnecessary production of scrap.

Returning to Hartford in 1865, Mr. Billings acted as superintendent of the manufacturing department of the Weed Sewing Machine Co., where he introduced drop hammers for forging the parts of sewing machines, especially the shuttles, which had formerly been made in several pieces brazed together. In 1867 he patented a process for drop forging shuttles from a single piece of steel, thereby effecting a great improvement in this part. In 1869 Mr. Billings left the Weed Sewing Machine Co., and in company with Mr. Christopher M. Spencer organized the Billings & Spencer Co. to manufacture sewing machine shuttles. The company also was interested in the manufacture of the Roper repeating shot gun, which, however, resulted unsatisfactorily, and in 1870 the manufacture of drop forgings was taken up as a specialty and has continued so since. Mr. Billings has made a considerable number of inventions, including wrenches, ratchet drills, measuring instruments, etc. A variety of machinists' tools are now manufactured by the company, being finished from the drop forgings in the machine department of the plant.

Although closely identified with the early development of the drop forging business and in a large sense a pioneer in the industry, Mr. Billings considers that one of his most important achievements made in this line was as late as 1886, when his attention was first called to the existing method of making commutator bars for electric generators while on a visit to the Edison Electric Works. These parts, at that time, were made of two pieces of copper, set together so as to form the well-known characteristic shape, and secured by pins and solder. This method of manufacturing was expensive and frequent interruptions of circuit were caused by the parts becoming separated, thus necessitating the taking apart of the commutator before the part could be gotten out and repaired. Mr. Billings suggested that the commutator segments could be drop forged to shape from pure copper, but his idea was not considered feasible by the foreman of the department. Nevertheless, upon returning home, dies were made and in a few weeks he sent to the Edison Co. drop-forged commutator bars made from pure copper having a homogeneous molecular structure throughout and of great density, and obviously of high electrical conductivity. The cost of making commutator segments was greatly reduced by the drop-forging process and the efficiency of these parts increased to a corresponding degree.

Mr. Billings is past president of the American Society of Mechanical Engineers, succeeding from the vice-presidency in 1895 upon the death of Mr. E. F. C. Davis, then president.

* * *

THE MILAN EXPOSITION.

The Milan Exposition has been somewhat of a disappointment to machinery exhibitors who have gone to a heavy outlay in order to secure a creditable representation. The extreme heat in Italy during the summer months has kept the attendance at a low figure, but it was expected that this would improve as the weather became cooler, as there are many attractive features in the exposition and in the progressive city of Milan, which is the principal manufacturing center in Italy, the machine tool industry being particularly active at

present on account of the expansion in the automobile trade. The exposition is peculiar in occupying two distinct and separate sections of ground some distance apart, connected by an electric elevated railway, which is a small mint to its owners. The exhibits occupy one section of the grounds, and the other, which comprises the municipal park, is devoted largely to amusement features, being laid out in the attractive way which Europeans are past masters of.

There are two exceedingly good exhibits of American machine tools at the exposition—made by Stüssi & Zweifel of Milan, and Alfred H. Schütte. Stüssi & Zweifel showed six Brown & Sharpe machines in operation—a No. 3-A universal milling machine, a No. 5 plain milling machine, a No. 3 universal grinding machine, a No. 13 automatic gear cutting machine, a No. 2 automatic screw machine, a No. 13 universal and tool grinding machine—and the following: Five Pratt & Whitney machines, including a 10-inch toolmaker's engine lathe, a 2 x 26-inch turret lathe, a 6 x 48-inch thread milling machine, an automatic cutter grinder, a 12-inch measuring machine and a case of Pratt & Whitney's small tools, assorted; five Hendey-Norton machines, including a 24-inch x 12-foot lathe, 14-inch x 6-foot lathe, with taper attachment; 16-inch x 8-foot lathe, with taper attachment; 18-inch x 8-foot lathe; 24-inch shaper; a Barnes drilling machine and grinding machine, and a 36-inch Bullard vertical turret lathe.

The other exhibit is made by the Milan house of Alfred H. Schütte, showing a 21-inch Gisholt turret lathe and tool grinder, a Potter & Johnston semi-automatic turret lathe, new model, 8½ x 16-inch; a Lodge & Shipley 8-inch x 10-foot lathe for high-speed steel; an 18-inch x 8-foot Bradford lathe; two Cincinnati drills, 21-inch and 32-inch; a No. 1 Bickford radial (improved pattern); a Baker Bros. vertical cylinder boring machine; a Baker Bros. key seater; a No. 3 Landis universal grinder; two Cincinnati milling machines, No. 3 plain and No. 1½ universal; a Cincinnati tool grinder; two 2-inch Cleveland automatic lathes, one with three-hole turret head and one with five-hole turret head; a No. 4 Acme automatic lathe with four spindles; a 26-inch x 6-foot Gray planing machine; a complete plant of pneumatic tools with air compressor by the Consolidated Pneumatic Tool Co., Ltd., an American Machine Tool Company's oil separator; a Washburn drill grinder; a Peerless belt lacing machine, and a set of Starrett's tools and gages.

Other American firms show miscellaneous machinery, and there is the usual variety of manufactured articles representing the different European countries.

* * *

TIME SAVING IN EXTRACTING THE SQUARE ROOT.

It had been the writer's practice for some time, when doing work which required frequent extracting of the square root of quantities, to work with a handbook on his table opened to the table of squares and square roots. Often, however, the three places to which the primary number in these tables are generally carried did not suffice to give the required degree of accuracy. Under these circumstances the extraction of the root was carried as much further as was necessary by the usual methods outlined in the arithmetics. In looking over an algebra the other day, however, the writer's attention was called to a principle which was there explained and proven, to the effect that after $n+1$ figures of a root have been obtained, the remaining figures may be found by simple division. This principle has been found so useful that it is here described with the thought that it may save others quite a bit of mathematical drudgery.

Suppose it is required to extract the square root of 152,409,694. Pointing off in the usual fashion and finding the first three figures of the answer, either by comparing with a table of square roots as suggested, or by the ordinary method, our problem stands as follows, with the remainder given.

$$\begin{array}{r|l} 152{,}409{,}694 & 12300 \\ 151{,}290{,}000 & \\ \hline 1{,}119{,}694 & \end{array}$$

We have now found $n+1$ or three figures of the root. We can find the n or two remaining figures, as suggested above, by simple division. Multiplying the partial root by 2 in the usual manner and dividing the remainder by it we have:

$$\frac{1{,}119{,}694}{2 \times 12{,}300} = 45 +$$

which gives 45 as the next two figures of the root, so, adding the five figures thus obtained together, we have 12,345 + as the result. If we desire to proceed still further we may again find by simple division the answer to four places of decimals. We have found $n+1$, or in this case five figures, so that it is possible to obtain n or four figures more. After performing the division indicated above, we have 12,694 as the remainder; subtracting from this remainder the square of the portion of the root just found. This gives us

$$\begin{array}{lr} \text{Remainder} = & 12{,}694 \\ 45^2 \quad = & 2{,}025 \\ \hline & 10{,}669 \end{array}$$

Proceeding as before to divide this remainder by twice the quotient of the root already found and carrying the division out to the fourth decimal place we have

$$\frac{10{,}669}{2 \times 12{,}345} = 0.4321 +$$

which may be added to that part of the root previously found, giving us 12,345.4321.

It would now be entirely possible, having found nine figures of the root, to obtain eight more in the same way. To do this we would, as before, subtract from the remainder of the last division the square root of the quotient obtained by that division, and then divide the result by twice the portion of the root already found, carrying the division out to eight new places, which may be added to the answer. This process will be found easy with or without the help of the handbook, and gives the required results with considerably less calculation than would otherwise be necessary. A similar plan may be used in extracting the cube root. In this case after $n+2$ figures of the root have been found, n more figures may be obtained by dividing the remainder by three times the portion of the root already found. As this operation is repeated, however, it becomes more cumbersome in the case of the extraction of the cube root.

The process as applied to finding the square root may be expressed by the following rule:

1. Having found any number of figures of the root by any process, subtract the square of the portion of the root thus found from the original quantity.
2. Divide the remainder found, in Operation 1, by twice the portion of the root already found, carrying the quotient to one less number of figures than there are figures in the portion of the root already found. This quotient is to be added to the portion of the root already found.
3. Subtract from the remainder left after the division in Operation 2, the square of the quotient therein found, and divide the result by twice the whole root, so far as found, carrying the division to one less number of steps than there are places in the root so far as found. Add this quotient to the root so far as found.

On analysis Operation 3 will be found to be identical with Operations 1 and 2 combined. Operation 3 may be repeated until the cows come home, with increasing difficulty, but with increasing effectiveness in the number of new figures added at one operation.

R. E. F.

* * *

We are informed by Mr. J. F. Lockwood, manager of the Security Elevator Safety Co., New York, that the Cruikshank elevator safety was *not* involved in the scheme which certain elevator interests tried to foist on New York city some years ago; this took the shape of an ordinance which would have prevented other elevator safeties being used in that city, hence would have effected a virtual monopoly. Mr. Lockwood tells us that the Cruikshank device, owned by his company, has been adopted in a large number of the best buildings in New York City and in many of the government buildings throughout the United States. We are glad to make this correction, with reference to the article "Shock Absorber" in the July issue, and to know that the parties representing this interesting and valuable device were not in the deal referred to.

A NOVEL CRANK ARRANGEMENT FOR SINGLE-ACTING INTERNAL COMBUSTION ENGINES.

Mr. Robert H. Ramsey, of Philadelphia, has brought out a novel arrangement of crank mechanism for use with single-action internal combustion engines, by means of which the side thrust on the piston, during the power stroke is considerably reduced, and at the same time the portion of the revolution effected by this stroke is increased, while the length of crank for a given stroke is reduced. The difference between the ordinary and the Ramsey arrangement is that in the latter the center line of the cylinder runs in a line tangent to the crank circle, as is illustrated in Fig. 1. The solid circle shows the path of the crank in the Ramsey mechanism, and the broken line circle is the crank path of the ordinary

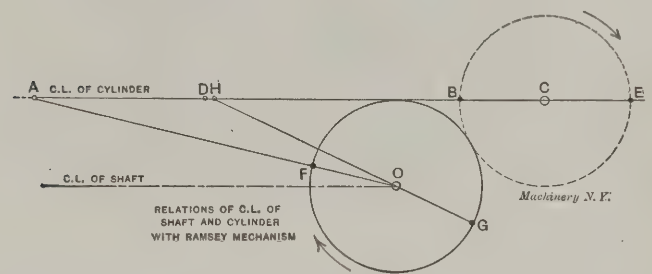


Fig. 1. Novel Crank Arrangement for Internal Combustion Engines.

design. In the latter design, the stroke *A D* of the piston is equal to the diameter *B E* of the crank circle, but in the Ramsey design the stroke for the same length of crank is *A H*. During the power stroke, the crank revolves from *F* over the upper part of the circle to *G*, which, as will be seen, is more than half a revolution. It will also be seen that for quite an angular distance just before reaching the half stroke the connecting rod is very nearly in line with the cylinder,

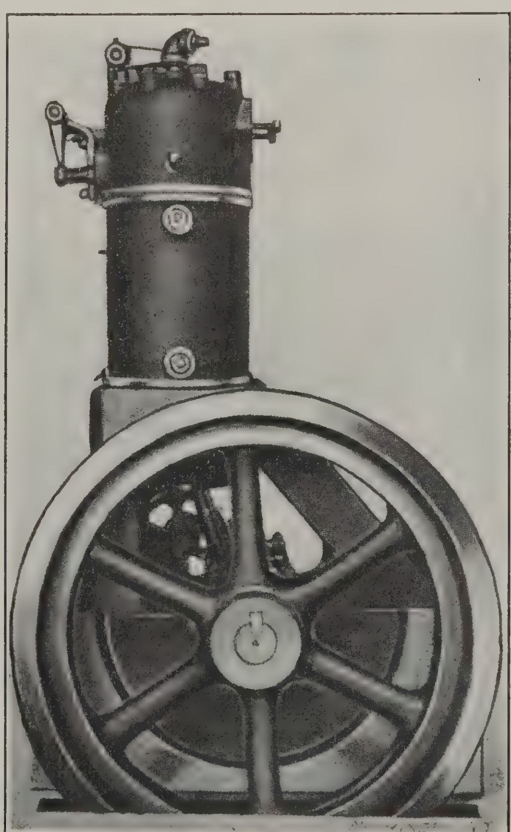


Fig. 2. Ramsey Engine showing Offset of Cylinder.

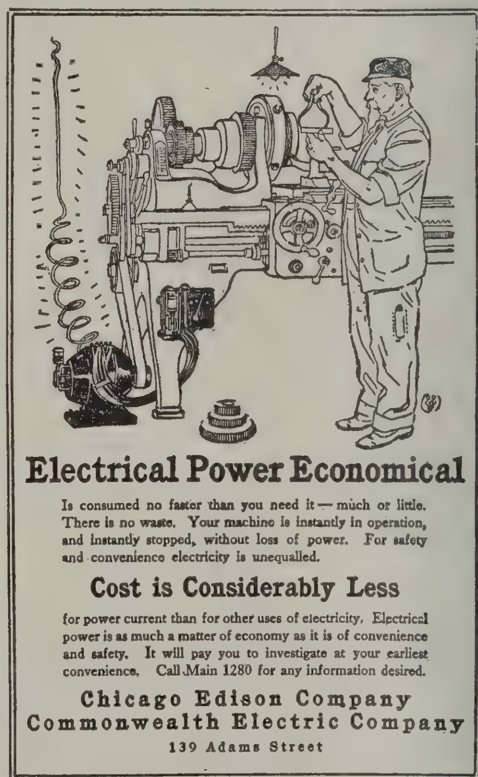
and at the beginning of the stroke the angle of the connecting rod is less than with the centrally located crank shaft. At the end of the stroke the connecting rod angle becomes greater, but at this point the pressure in the cylinder is greatly reduced; therefore, taking the power stroke as a whole, the side thrust is considerably less than with the standard arrangement of crank, and on that account the connecting rod can be made shorter. During the compression stroke the connecting rod angle is greater than with the central crank shaft, but at the same time the compression pressure is only about one-quarter of the working stroke pressure, and during the first part of the stroke, when the angle is greatest, the compression is very low, so that taken all in all, what is gained in reduced side thrust on the power stroke is much more than what is lost during the compression stroke.

W. B. Jr.

[The Ramsey crank mechanism discussed in the preceding paragraphs has been fully described in most of the technical papers of the country. We do not, however, remember to have seen it mentioned that one of the most interesting things about it is the fact that it at once invites discussion, first, as to the patentability of the principle involved, and second as to the usefulness of the device. If the patent granted covers the principle of locating the center line of the cylinder tangent to the circle described by the crankpin, this claim could be avoided by moving the cylinder slightly to one side or the other of its position. If the absolute location of the cylinder axis is not important, but merely the principle of offsetting the cylinder, that has been used for many years, notably in the case of the Westinghouse "standard" steam engine, of which thousands have been built with the center line offset by an amount equal to one-half the crank length. Granting its patentability, a little thought will still show that the claims made for the device, while they may be valid, cannot be expressed and proved in the simple fashion in which the promoters of the device have undertaken to do it.—Editor.]

* * *

SOMETHING NEW IN MOTOR DRIVE!



—From Chicago *Daily News*.

* * *

A BURGLAR-PROOF VAULT.

Mr. Morris M. Defrees, a civil engineer of Indianapolis, has designed a safe deposit vault, which is described in the *Cement Age*. The initial step in the construction of this fire- and burglar-proof vault consists in the erection of a cage around which concrete is poured. This cage covers the sides, top and bottom of the vault, and is composed of a lattice work of ¾-inch gas pipe, each pipe having inside a steel bar ½-inch in diameter. Assuming that the burglar had the good fortune to get through the concrete and the pipe, he would meet an insurmountable difficulty in striking the bar, for his saw would then come in contact with a movable body on which no purchase is possible. It is suggested that the reinforcing cage be made double with the vertical and horizontal bars of the outer cage staggered in relation to those of the inner cage. Mr. Defrees advises, in the making of the concrete, a mixture of 1 part of cement and 3 of sand as being harder than concrete containing stone or gravel.

LETTERS UPON PRACTICAL SUBJECTS.

THREE-SPINDLE DRILLING ATTACHMENT.

There is nothing elaborate in the construction of tools for the manufacture of dental chairs, because there are constant changes being made in the design of the product which necessitate sometimes a radical change in the tools, even to discarding some of them altogether. The part of the chair called the "cylinder" has three holes drilled in it, equally spaced around its periphery. These pieces have heretofore been drilled at the rate of two per hour, but with the three-spindle attachment herein described, we drill five per hour with accurate results. We have a number of Snyder drill presses in the shop, and it is to one of these that the device is shown attached in Fig. 1. Its members are fastened together in such a way that they may be detached easily and the press used for other work. Details of the device are shown in Fig. 2.

Referring to this cut the outline shows a bracket-shaped piece, *A*, planed to fit the column of the press; the gibbs *D D'* are held on with retaining bolts (not shown). The flange of the bracket *A*, shown at *e*, is bolted to the spindle bracket and the whole fixture is attached to the machine by the bolts at this place. The spindle bracket when lowered to the limit of its travel, lets the bearing of *A* drop off the bearing on the column. Member *B* is a separate casting, but when bolted to *A*, forms a single unit with it. *B* is the carrier of the three spindles which are driven by cast-iron spur gears on their upper extremity; these three gears (26 teeth, 8 P. one-inch face) are driven by a gear of the same size, in the center, keyed to the spindle of the press. The thrust of the central spindle against the member *B* is taken up by a taper shank piece that carries on its end a ball thrust; this is seen at the dotted lines in the side view, Fig. 2. Ball thrust bearings are provided for each of the three spindles also, as shown. Each spindle is fitted with ball chucks and collets and in drilling this identical job, two sets of Novo drills are employed; the ones seen in the photo are ½-inch drills with extension shanks; on the box in front of the press is the other set, 55/64 inch diameter.

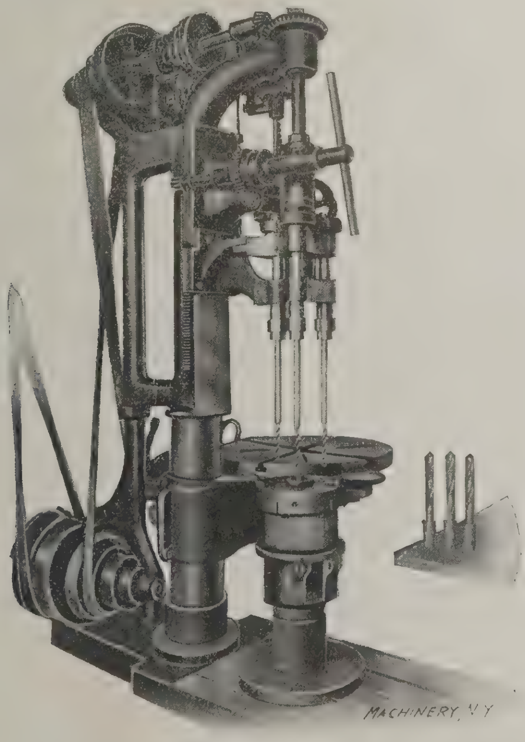


Fig. 1. Drill Press with Three-spindle Drilling Attachment.

The jig is located central with the spindle by means of a hole in the bed, which is exactly in line and central with the spindle; into this hole fits a projection or lug on the bottom of the jig itself.

To remove this attachment, the jig is moved to one side, the drills withdrawn, and the table swung back into place; the fixture is then lowered until the chucks rest on the table, the bolts at *e* are released and the spindle is then free to be raised up and out of *B*. The central gear comes with it, but as it is a slip fit on the spindle it is quickly removed. The fixture being now below the before mentioned bearings of the column it can be laid aside and the press used for other work.

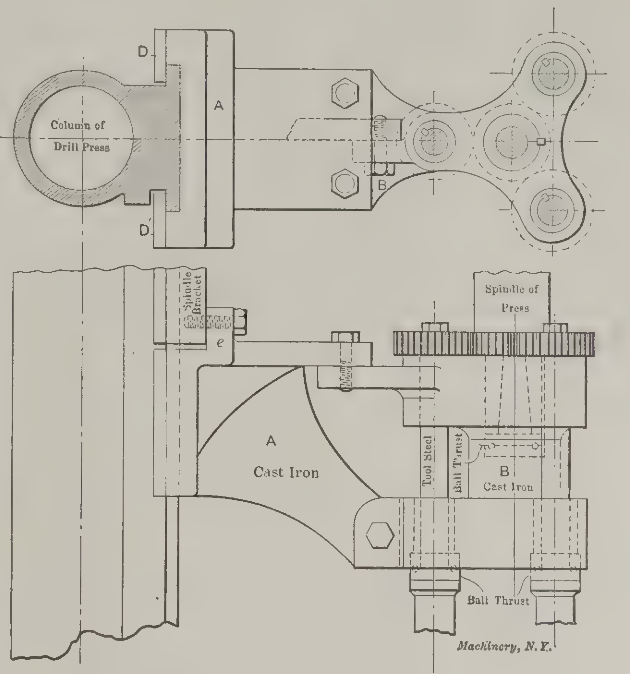


Fig. 2. Details of Three-spindle Drilling Attachment.

The gears are nicely protected by a cast gear guard. It is of course understood that to drive the drills in the right direction, the up and down belt must be crossed.

Rochester, N. Y. CARROLL ASHLEY.

SOME HINTS FOR DRAFTSMEN.

From time to time there have appeared numerous articles relative to drafting room methods, but there are still perhaps many minor suggestions which would be appreciated by many if they were presented.

For example, there is a chance for improvement over the method which is in vogue regarding furnishing the machine department with a print containing many dimensions which do not in any way concern it, but which are used by the patternmaker only. When the pattern has been made and castings made from it, and finally, when the machine is finished and no alterations are to be made on the pattern, the pattern dimensions should be omitted from the machine shop print. It is sometimes customary to make two tracings to accomplish this if the piece is complicated, such as machine beds, etc., but the following method has the advantage of requiring but the one tracing. A finished tracing is made containing all dimensions both for the patternmaker and machinist. The dimensions for the machinist are inked in as usual, but the pattern dimensions are put in with a soft lead pencil. Several prints are taken from the tracing while in this condition, one furnished the pattern shop and as many filed away as desired. The lead pencil dimensions are then erased and the tracing is ready for making prints for the machine shop. In this way the patternmaker can readily understand and pick out his figures, and the machine shop print is kept free from unimportant dimensions which ofttimes cause considerable trouble.

It is sometimes desired to make a tracing of cuts from catalogues, books, etc., and to do this without removing the page. Perhaps it is not well known that by wetting the edges of the starchy side of tracing cloth and rubbing it on the page that it will adhere firmly and the tracing can be done on the dull side without much trouble.

I have found it a good plan when leaving a tracing on the board at night to remove all the tacks from the drawing and tracing except the one which is in the center of the top edge and the one which is in the center of the bottom edge. This allows it to go and come and to be tightened readily in the morning.

In spacing a line for screw threads when it is desired to represent the V, the thread gage furnishes the means as well as anything could; simply choose the pitch and make the impressions.

I have often found that when lines on an outer circle are to be drawn tangent to an inner circle that a cardboard disk is a good substitute for the eccentrolinead and is as much better than a circle as is a pin put in the center for radiating lines, than a lead pencil point.

In order to have a scale divided to one-fourth and one-half size it was necessary to make one, as they are not on the market. The object of making one was for checking purposes only; it could hardly be used for constructing for any length of time, as it is made of paper strips pasted on a wooden strip and shellacked over. The divisions are on bristol board and are engine divided. These paper scales can be procured for a small sum. This makes an excellent rule for checking drawings made one-fourth to one-half size.

It is well to have a piece of blotting paper 2 x 3 inches hung on the wall, for when it is needed it is wanted in a hurry, and this makes a convenient place for it.

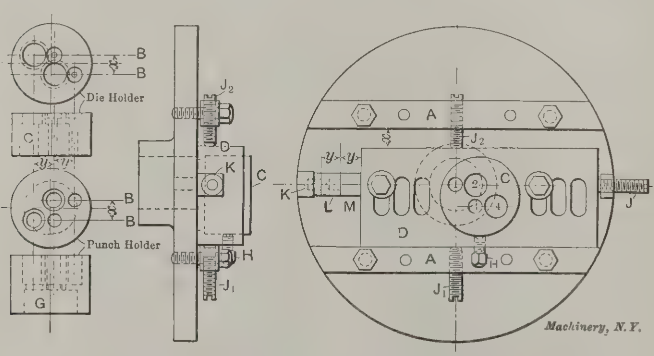
Various means have been devised to keep tracings flat in drawers. They will continue to curl up if the ink is put on the smooth side, but will lay flat of their own accord if ink is put on the dull side.

A small flat oil-can with screw top is very convenient to have among the draftsman's kit; if oil is used frequently on the screws and nuts of instruments they not only work better but last much longer. WINAMAC.

A FACEPLATE RIG FOR BORING PUNCH AND DIE HOLDERS.

At C and G are shown a die holder and a punch holder respectively. In making them the important point to be considered is that the lines B, B, in each case, must be parallel. The rig used to accomplish this is shown in the cut.

The faceplate of the lathe in which the holes were to be bored was taken to the drill press, where it was drilled and tapped to receive the "hexhead" screws and dowel pins by which the two steel strips A and A were fastened to it. In clamping these pieces to the faceplate, cardboard strips about ⅛ inch thick were inserted between them and the faceplate.



Faceplate for Boring Punch and Die Holders.

The faceplate was next taken to the planer and leveled there with the surface gage, face up, and the inner edges of the strips A were planed parallel to each other. The cardboard, in this operation, saves the surface of the faceplate from injury.

Block D was next machined to such a width that, when placed between the strips A and A, dimension x was the same as on pieces C and G. In the center of this block a recess was formed to receive the blank for the punch and die holders, and a setscrew, H, was used to hold them in place. The block D was slotted as shown to accommodate the two bolts used to secure it to the faceplate. Screws J_1, J_2 were tapped into the side strips and in a post at the edge of the plate to adjust block D. In another post, K, were set two plugs, L and M, of which the latter had a projection which telescoped in the first, which in like fashion set in the post. Dimension y of these plugs was made the same as y on punch and die holders C and G.

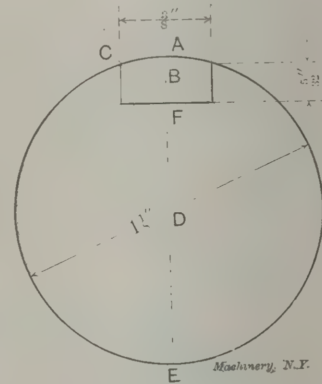
In using the device, the work is clamped in the block D by setscrew H, and with the parts arranged as shown, screws J are tightened up, the block is clamped to the faceplate, and hole No. 1 is bored. The screws are loosened, distance piece M is removed, and, with the screws tightened up again and the other parts arranged as before, hole No. 2 is finished. It is, of course, understood that screw J_1 has not been used all this time. Screw J_2 is now withdrawn and J_1 tightened until the block D seats against the upper strip A, when it is clamped and hole No. 3 is bored. Distance piece L is then removed and the last hole, No. 4, is completed.

This arrangement assures the parallelism of lines B and B in the work, and also makes it certain that the punch will exactly match the die. R. E. HARRYMAN.

Louisville, Ky.

MEASURING KEYWAYS.

I was once milling some keyways that were supposed to be pretty accurate, but the dimension given for depth was not such as could be measured accurately. The depth was given as 5/32 inch at the sides of the cut; now, the cutter could be set for depth comparatively accurately by raising the milling machine table until the cutter was cutting the full width of the keyway and then raising the table 0.15625 inch (= 5/32). This is not very reliable, however, as you cannot see within 0.003 to 0.005 inch and after taking the cut a burr is thrown up at the edge. In filing this off one is apt to take off more or less of the shaft with it, and furthermore the only way to get the depth measurement is with a scale. The first keyway that the boss inspected, seemed to him a trifle deep, but I filed off a little more of the burr (?), and that made it all right. But I wasn't satisfied and wanted some way to measure the depth accurately, with a micrometer, if only to ease my own conscience. I could measure the distance, FE, from the bottom of the keyway to the bottom of the shaft, but what was this measurement? I got a piece of brown paper and borrowed a pencil and started in, while the cutter was running through the next shaft, and soon had it.



Measuring the Depth of a Keyway.

In the right triangle CBD, CD is the radius of the shaft, which is 9/16, or 0.5625 inch, and CB is half the width of the keyway which is 3/16, or 0.1875 inch. Find the side BD of the triangle.

$$(BD)^2 = (9/16)^2 - (3/16)^2$$

$$BD = 0.530 \text{ inch.}$$

Then subtract this from the radius AD,

$$0.5625 - 0.530 = 0.0325 \text{ inch} = AB.$$

Then the whole depth of the keyway from the top of the shaft is $AB + BF$, or

$$0.0325 + 0.15625 = 0.18875 \text{ inch} = AF.$$

Subtract AF from AE to get FE.

$$1.125 \text{ inch} - 0.18875 \text{ inch} = 0.93625 \text{ inch} = FE.$$

Then, when you want to cut the keyway, set the cutter touching the top of the shaft, and run up the table the distance $AF = 0.18875$ inch; and when you want to inspect the finished work, measure $F\ E$ with the micrometer for the dimension 0.93625. C. E. BURNS.

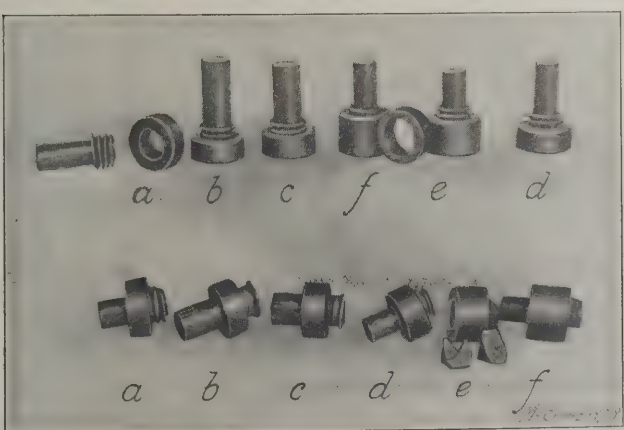
Beverly, Mass.

THE COMPARATIVE STRENGTH OF SCREW THREADS.

C. Bert Padon.

There has been considerable discussion from time to time among mechanics with whom I have worked, as to which of the three forms of thread, V, square and Acme, is the strongest against shear. Having an opportunity during my junior year at the James Millikin University, Decatur, Ill., to do a little laboratory work, I undertook to settle this question with the idea of determining as nearly as possible with the means at hand just what relation these styles of thread bear to each other.

Each of the three forms was tested under two different conditions. First, a screw and nut of each form was made with threads all the same outside diameter, 15/16 inch, and with both screw and nut of the same axial length, 17/32 inch, and of the same material, the grade of steel commonly known in the shop as "machine steel." These three samples are shown at *a*, *b* and *c* in the photograph, in which *a* is the V-thread, *b* the Acme thread, and *c* the square thread. In the second test all three screws were of the same root diameter, about ⅝ inch, and were all made of gray cast iron, while the



Test Pieces used for Finding the Comparative Strength of Screw Threads.

nuts were of machine steel. The length of the thread helix in each screw was such that each of the samples would present the same shearing area, the assumption being that they would shear at the root diameter of the screw since the screw was made of the weaker material. The different thicknesses of the nuts to suit the length of the helix required for this will be noticed in the halftone at *d*, *e*, and *f*, which show respectively the V-thread, Acme and square samples. All the threads were made a snug fit, with the threaded length of the screw exactly the same as the thickness of the nut. The diameter of the shank was less than the root diameter of the thread in each case. The screws were all 6-pitch.

In the cut the upper row shows the samples before testing, while the lower row shows the nature of the failure of each sample under test. A 50,000-pound Olsen machine was used. A nut was supported on the ring shown with sample *f* to allow room for the screw to drop through the nut when it failed, while pressure was applied at the top of the shank, which was carefully squared. The shank of the Acme thread screw *e* in the second set of three samples was not strong enough to withstand compression but crushed before the thread gave way, at a pressure of 29,300 pounds. The fragments of the broken shank are shown. The screw was afterwards pushed through with a short piece of steel rod, failing at 29,600 pounds pressure. The accompanying table gives the results of the test.

RESULTS FOR TESTS OF SHEARING STRENGTH OF SCREWS.

Sample.	Style of Thread.	Material. Screw.	Material. Nut.	Thickness of Nut.	Diameter of Screw.	Breaking Load in pounds.	Remarks.
Threads same outside diameter and all 6 pitch.							
a	Sharp V	M. S.*	M. S.	17/32	15/16	29,980	Threads bent over in both screw and nut.
b	Acme	"	"	"	"	34,090	Sheared at root of screw.
c	Square	"	"	"	"	23,880	" " " " "
Threads same root diameter, ⅝ inch, and same area of section to resist shear. All are 6 pitch.							
d	Sharp V	C. I.*	M. S.	½	.914	20,450	Sheared at root of screw.
e	Acme	"	"	13/16	.792	29,600	Shank crushed at 29,300 pounds, pushed through with steel rod and sheared at root of screw.
f	Square	"	"	1	.792	25,550	Sheared at root of screw.

* M. S. stands for Machinery Steel; C. I. for Cast Iron.

As will be seen from the above table, the Acme, or 29-degree thread, makes the best showing in each case. This has been an interesting experiment to me and I am sure it will prove of some value to at least one firm who was interested in the experiments, and who has adopted the Acme thread as a feature in the design of the machinery constructed in its shops. C. Bert Padon.

Decatur, Ill.

[The V-thread sample, *a*, evidently could not have failed in the way described without expanding the nut enough to allow the distorted threads to slip by each other. In this case then, the thickness and strength of the nut play an important part. If the hole had been tapped in a larger piece of metal, it is difficult to believe that the thread would have failed by shearing or in any other way at a pressure less than that sustained by the Acme thread.—Editor.]

C. Bert. Padon was born at Troy, Ill., December 17, 1870. Besides a common school education he has graduated from Brown's Business College, Decatur, Ill., has taken a correspondence course with the International Correspondence Schools, and is now completing his fourth year at the James Millikin University, Decatur, Ill. He served an apprenticeship as machinist with The Decatur Novelty Works and has since worked as a machinist for that firm and the H. Mueller Mfg. Co., of Decatur. He has also held for two years the position of assistant instructor in machine shop practice in the school he is at present attending. His specialty is experimental work.

ADJUSTABLE SCALE FOR LAYING OUT TABLE.

Among the suggestions received from a man engaged in the tool-room, was one for an adjustable scale for use in setting off vertical heights on the laying-out table, and as the idea seemed good, permission was given to him for making the device himself, according to his own ideas. Fig. 1 shows the tool as made. It consists of a cast iron base, *A*, a round slide *B*, carrying a 12-inch flat steel rule, *C*, adjusted for height by means of the screw *D*, slide and rule being clamped by means of the screw *E*. Its use can be best explained by an example: It is required to set out two lines on opposite faces of a casting, say 5 3/16 inches apart, the lower line being the center of a boss about four inches from the base. The center of the boss being obtained by means of dividers or other instruments, a height gage is adjusted to this center and a line marked across the face of the boss. The height gage is then trans-

ferred to the adjustable scale where it indicates, perhaps, about 4 3/64 inches. Now instead of adding 4 3/64 inches and 5 3/16 inches together, with the consequent risk of error, the scale is adjusted by means of the screw *D* until the 4-inch division is opposite the pointer on the height gage, and it is then an easy matter to add the 4-inch and 5 3/16-inch together, setting the height gage to 9 3/16 inches, this giving the distance apart required.

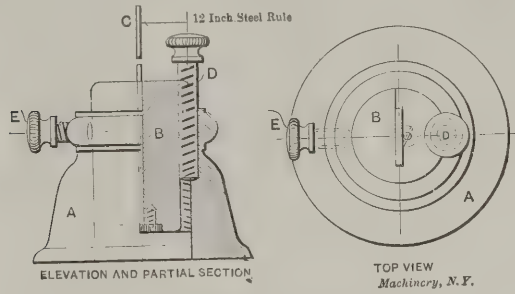


Fig. 1. Adjustable Scale for Laying Out Table.

Upon my accepting an appointment in another shop later, the need was observed there for something similar, and the above device was recalled, but although the idea was good, an improvement suggested itself to me, this being embodied in the scale shown in Fig. 2. In principle the device is the same but instead of the flat scale as originally used, a 12-inch triangular scale was substituted, the lower end of this resting on a projection at the foot of plunger *F*, this plunger being supported by the spring *G*. Adjustment of the scale is effected by means of the nut *H*, the spring keeping the upper end of the scale always against this. Two advantages of this later device are that readings can be taken much nearer the base, and the scale can be used for measuring against a face at times, without the assistance of a height gage.

The graduations on the triangular scale, which was a Brown & Sharpe No. 246, were No. 20, being fully divided along one edge of each face in 1/16, 1/64, and 1/100. It is an easy matter to remove the nut and change the scale to bring any of the divisions to the front.

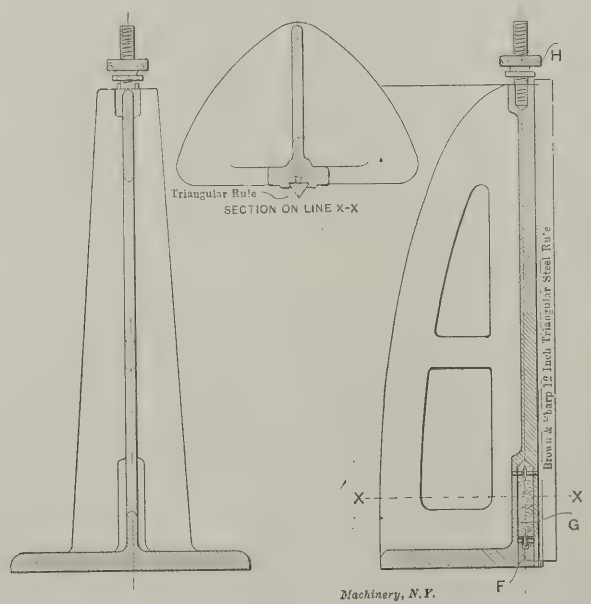


Fig. 2. Adjustable Scale for Laying Out Table.

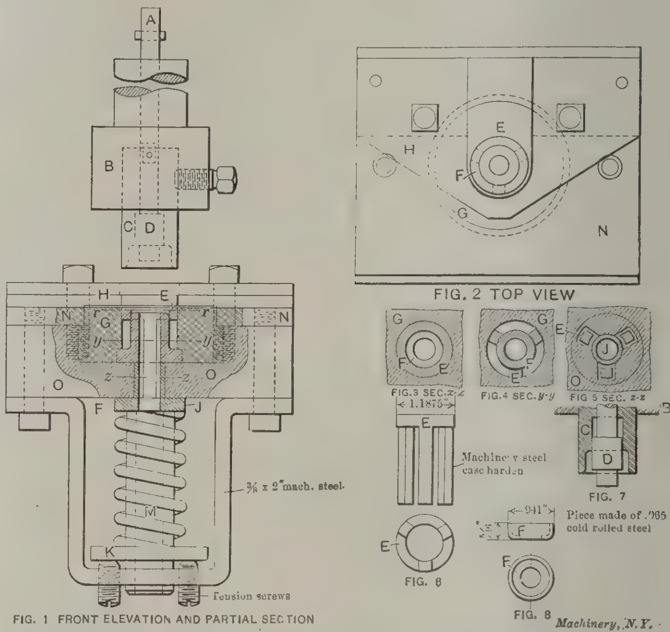
If the inventor of the original device should read this I hope he will forgive me for "pirating" his idea. I can certainly testify to its utility and I hope he will feel pleased that it has now been given publicity for others to copy or improve upon where not already known.

George D. Hadun.

MAKING A BALL-BEARING CUP IN A SINGLE ACTION PRESS.

Having a cup to make for a ball bearing which required rapid and cheap production of the parts, I designed the die shown herewith to produce the same on a single action press, as we have no double-action press.

The die block *O* is of mild steel, with a 3-inch round plug *G* set into the center, which plug is held down by the ⅜-inch plate *N*, shown in Fig. 1. Inside and concentric with this is a combined forming and piercing die *F*, projecting up to within ⅛ inch of the face of die *G*. Between the outer and inner die is a spring stripper pad, detailed in Fig. 6, which forces the finished cup into the punch as it recedes. This pad is held in the position shown by the thimble *J*, which is in turn supported by the stiff spring *M* bearing on washer *K* and the adjusting screws beneath it. The section views, Figs. 3, 4 and 5 make this construction clear. The back gage and scrap stripper *H* are cut away in the back, as shown in Fig. 2, so that as work falls out of the punch it will not catch on the die, but will slide off easily, being used on an inclined press. The upper die or punch consists of 1 3/16 inch blanking punch *C* with the inside formed to draw the sides of the cups and with a central punch *D* for piercing the center hole, which, by the way, does not need to be accurate in size.



When the ram descends, with the stocks in place, blanking punch *C*, in conjunction with die *G*, first cuts out a disk of the proper diameter. As the ram continues to descend, and blank and pad *E* are carried down against the resistance of spring *M* until die *F* is met, when the stock is drawn into the required cup shape. Continued movement punches the central hole through the action of punch *D* on die *F*. As the ram rises, spring *M* and pad *E* force the work into the punch *C*, from which it is ejected at the top of the stroke through the action of central punch *D*, as shown in Fig. 7. The work drops off from *D* readily, since the fact that it is drawn and punched simultaneously produces a hole about 1/64 inch greater than the diameter of the punch.

With this die we can produce from ten to twelve thousand of the cups in ten hours, with a boy running the press.

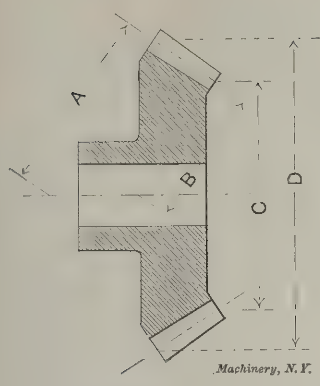
Aurora, Ill. Corwin Lamoreaux.

CUTTING BEVEL GEARS.

I have run across a way to cut bevel gears, which eliminates the guess work necessary in the ordinary "cut and try" method of milling them, in which two or three gears are bungled before the number of holes to turn the dividing head, and the amount to set the cross-slide off center is discovered.

Find the standard spur gear cutter for the large end in the usual manner, finding the pitch by dividing the number of teeth by *D*, and the number of teeth by which to select a cutter by multiplying twice *A* by this pitch. Find a cutter for the small end of the teeth in the same manner, using the measurements *C* and *B*.

Then run the cutter for the small end through one tooth at the right depth, which will give the correct shape of the tooth at the small end; also run in the cutter for the large end, set at correct depth, until it cuts its full depth. Then



CuttingBevel Gears.

take the cutter for the large end and set it so it will trim as near as possible to the sides of these two cuts. By this method you will know just where you are at, and can easily set your machine to cut as perfectly as possible. If you want a special gear for some job, which must be pretty near right, run the cutter for the small end through all the teeth and then you will have a correct surface to file to. C. E. BURNS.

Beverly, Mass.

METHOD OF CUTTING LATHE LEAD SCREWS.

The annexed Fig. 1 shows a method I have used for cutting lathe lead screws which has worked out very well. As usual two cutting tools are used, one in front, right side up, and the other at the back, also right side up, to cut on the reverse trip. The cutting tools in this case were round, like short

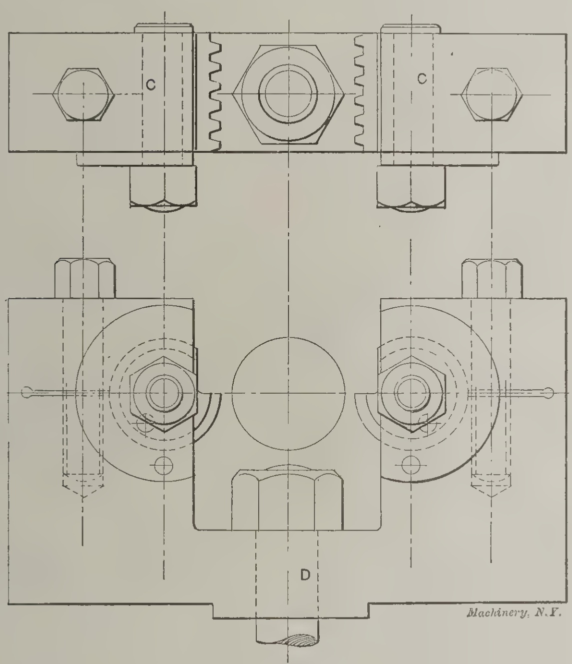


Fig. 1. Double Tool-post with Circular-formed Threading Tool.

sections of the screw to be cut but left-hand to cut a right-hand screw. They were cut with the thread on a taper and the outside turned straight so that the leading cutter tooth cut to the full depth that we could take at each traverse and the succeeding teeth widened the cut, only the last two usually cutting in the full side of the thread, as shown in Fig. 2.

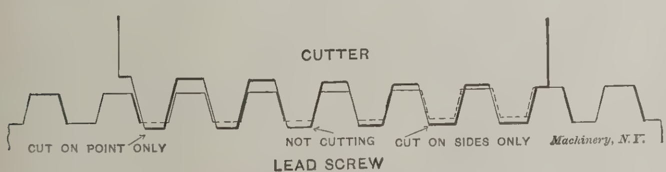


Fig. 2. Illustrating the Cutting Action of the Tools.

The limiting element in using this device became the torsion of strength of the screw we were cutting. We found on our 16-inch size that it was cheaper for us to use 1½-inch stock than 1¼-inch on average lengths just on this account because the time saved in cutting more than covered the increased cost of stock.

The bolts *C C* and their washers and nuts were an afterthought and helped to hold the cutters in place. The dowel pins had to be changed every few grindings. Bolt *D* held the device to the top of the cross slide, in place of the tool post.

Worcester, Mass. E. H. FISH.

THE CONGESTED CONDITION OF THE PATENT OFFICE.

Referring to the condition of the Patent Office at Washington, D. C., regarding the number of applications awaiting action, you will notice by reference to the accompanying statistics that on August 28, 1906, there were 23,811 cases awaiting their turn to be examined. You will also notice that the previous week showed that there were 23,523 cases, consequently the office got behind, in one week, of some 288 cases. This same condition has been partially true of some of the previous weeks, as you will note by reference to the table. Now, if we assume that the Patent Office is going to continue getting back from week to week (and we have every reason to so assume, judging from the table of figures), we can look for nearly 30,000 cases awaiting action by this time next year; this is figuring on the last week's gain of 288 cases.

1906.	Applications Awaiting Action.	Patents Granted.	1906.	Applications Awaiting Action.	Patents Granted.
Jan. 2	17,353	669	May 8	21,417	699
Jan. 9	17,256	659	May 15	21,414	670
Jan. 16	17,471	461	May 22	21,501	671
Jan. 23	17,752	521	May 29	21,507	646
Jan. 30	17,916	643	June 5	21,408	690
Feb. 6	17,891	655	June 12	21,612	614
Feb. 13	18,086	639	June 19	21,656	604
Feb. 20	18,007	611	June 26	21,813	621
Feb. 27	18,246	628	July 3	21,915	602
Mar. 6	18,860	645	July 10	21,958	603
Mar. 13	19,152	676	July 17	21,923	643
Mar. 20	19,192	627	July 24	23,022	649
Mar. 27	19,613	634	July 31	23,139	647
Apr. 3	19,958	606	Aug. 7	23,436	598
Apr. 10	20,263	605	Aug. 14	23,647	592
Apr. 17	20,609	671	Aug. 21	23,523	528
Apr. 24	20,846	640	Aug. 28	23,811	586
May 1	21,406	689			

At the present time most of the divisions which have such classes as automobile parts, machinery, tools, appliances and other divisions with kindred devices, are some eleven months in arrears on *new* work, or on work which has not been heretofore examined, while they are from three to six months behind on responses or amended work. Now, judging from the figures given above, is it not reasonable to believe that this time next year, we shall be waiting about eighteen months on new work and about eleven or twelve months on amended work? Now, what does this mean? It means in the first instance, industrial discouragement, as well as financial discouragement. The man who would invent will not do so unless he sees some immediate return for his labors and the man who would put up money will not do so in view of the fact that the inventor can not get his patent quick enough. Again, the Patent Office is going behind, the race of competition is going ahead—the results are obvious.

Over against this condition of affairs, there is a bank account to the credit of the United States Patent Office of nearly $7,000,000, and this fund is growing daily. Congress, it would seem, is the only power that can adjust these matters, and yet no one seems willing to take the matter up and push it to completion. Some two or three years ago the New York *Times* made some faint efforts toward rectifying the situation, but nothing came of it. I propose that some measure for relief be pressed at the coming session of Congress. FRED. W. BARNACLO.

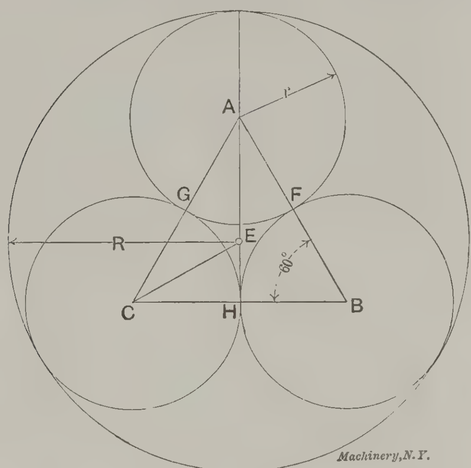
New York.

ANOTHER ANSWER TO THE TANGENT CIRCLE PROBLEM.

In the April issue of MACHINERY there appeared an article in the How and Why column discussing the method of finding the radii of three small tangent circles, tangent to and within a bounding circle. I present herewith a method of solving this problem by geometry alone and also show a way of finding the area of the figure *GFH* bounded by arcs of the three small circles. We will take the second of these problems first.

To find the area *GFH* within and bounded by the three tangent circles *ABC* when the given quantity is the radius of the small circle: Construct the triangle connecting the

centers of the circles at ABC. Then find the area of this triangle and subtract from it the area of the three sectors FGA, GHC, HFB. The angle of one sector is 60 degrees and the three together will be $3 \times 60 = 180$ degrees or ½ a circle. Hence if r is the radius of the small circle, the area of the desired figure will be equal to the area of the triangle ABC minus the area of a semi-circle with radius r. The area of the triangle $= \frac{1}{2}\,CB \times AH = HB \times AH$. But $AH = \sqrt{\overline{AB}^2 - \overline{HB}^2}$; now assuming that the radius of each small circle is unity or 1, the equation becomes $AH = \sqrt{2^2 - 1^2} = \sqrt{3} = 1.732$. The area of the half circle with a radius of unity or $1 = \frac{3.1416 \times 1^2}{2} = 1.5708$. Hence $1.732 - 1.5708 = 0.1612 =$ the required area, which multiplied by the square of any numerical value for radius r gives the area numerically. If, for instance, $r = 2.5$, the area of FGH will be $2.5^2 \times 0.1612 = 1.0075$ square inches.



Problem of Three Tangent Circles.

To find radius r when the radius R of the bounding circle is given: CEH and ACH are similar triangles. From this fact we get the proportion $CH : AH = EH : CH$, or $CH^2 = AH \times EH$. In the previous problem we found that when CH or $r = 1$, $AH = \sqrt{3}$. Substituting these values in the equation we have $1 = \sqrt{3} \times EH$, or $EH = \frac{1}{\sqrt{3}}$. Now $(AH - EH) + 1 = R$ when $r = 1$. Substituting numerical values for AH and EH, we have: $R = 2.1546$. Hence $r : R = 1 : 2.1546$. Therefore $r = \frac{1 \times R}{2.1546} = 0.464\,R$. From this it follows that if the radius of the large circle is known it is only necessary to multiply it by 0.464 to find the radius of the small circle.

Philadelphia, Pa. SAMUEL AROSON.

[In the answer to question No. 16, "How and Why," of the April, 1906, issue of MACHINERY, to which our correspondent refers, an error was made in the table given in the answer. The second and fourth columns should be headed r, and not $2r$, as they are given.—EDITOR.]

A WAY TO INDEX DATA SHEETS.

I show herewith a method of indexing my MACHINERY data sheets. The cut, I think, explains itself, since it is a copy of part of my own index. As will be seen, the data sheets are published, and each one is given a page number in the file which is entered opposite the title in the index. Wherever there is more than one table to a page they are entered separately, as shown for page 102, for instance. The right-hand side of the index is ruled vertically, one for each letter of the alphabet. In these columns crosses are placed to indicate the leading words in the title or subject of the data sheet referred to; for instance, page 110, Table of Gib Keys has a cross under B for "Buffum," the contributor of the table, under G for "gib," under K for "key," and under T for "table." In looking for this particular sheet, if the reader has the word "gib" in his mind, he will follow down the column G, glancing at each title which has a cross opposite it in this column until the right one is reached, which will be done in less time than it takes to describe the operation.

JOHN ROE.

Philadelphia, Pa.

PAGE NO.	DESCRIPTION	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
101	WEIGHT OF ROLLED SHEET METALS													×					×	×				×			
102	WEIGHT OF SUPERFICIAL FOOT OF CAST IRON			×						×														×			
"	WEIGHT OF NUTS & BOLT HEADS IN POUNDS		×												×									×			
"	SPECIFIC GRAVITY & WEIGHT OF METALS													×						×				×			
103	WEIGHT & AREA OF COLD ROLLED STEEL SHAFTING	×		×																×				×			
104	APPROXIMATE WEIGHT PER IN. FACE CAST IRON GEARS							×																×			
105	PIPES & PIPE FITTINGS (PAPER BY J. B. BERRYMAN)		×				×										×										
106 & 107	WHITWORTH'S STANDARD SCREW THREAD FOR BOLTS		×																	×	×			×			
108	WHITWORTH'S SCREW THREAD FOR GAS & WATER PIPE																×			×	×			×			
109	PROPORTIONS FOR PLAIN BEARINGS (CHILDS)		×	×													×										
109	PROPORTIONS FOR WRENCHES (CHILDS)			×													×							×			
110	TABLE OF GIB KEYS (F. D. BUFFUM)		×					×				×									×						
111	PROPORTIONS FOR COLLARS (G. W. CHILDS)			×													×										
"	PROPORTIONS FOR HAND WHEELS (G. W. CHILDS)			×					×								×							×			
112	PROPORTIONS FOR PLATE COUPLINGS (G. W. CHILDS)			×													×										
"	PROPORTIONS FOR FLANGES (G. W. CHILDS)			×			×										×										
113	DIAGRAM OF JOURNAL FRICTION (R. A. GREENE)				×		×	×			×																
114	DIAGRAM OF CHAIN FRICTION (R. A. GREENE)			×	×		×	×																			
115	STANDARD DRUM SCORES (R. A. GREENE)				×			×												×							
116	STANDARD SOFT STEEL ROPE SOCKETS WITH PIN																		×	×							
117	COMPARISON OF MONEY STANDARDS			×										×						×							

Method of Indexing Data Sheets.

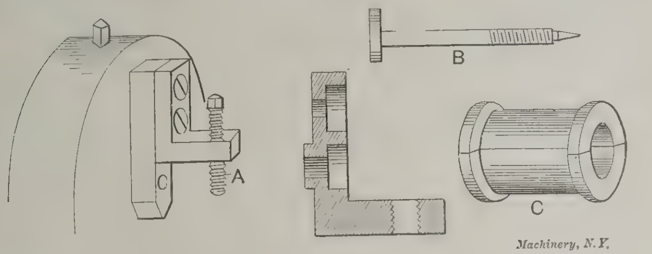
SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

CHUCK JAW.

The sketch herewith is of a jaw for the lathe chuck, to take the place of the removable piece of the chuck jaw on some work, mostly repair jobs. As a chuck wears, the jaws spring outward, and the inner end of the jaws grip the piece long before the outer end, and the more the jaws are tightened the more this difference is exaggerated. The outward end of a long piece is sure to wobble and it is almost impossible to get it true, and then to keep it so. The attachment



A Handy Chuck Jaw.

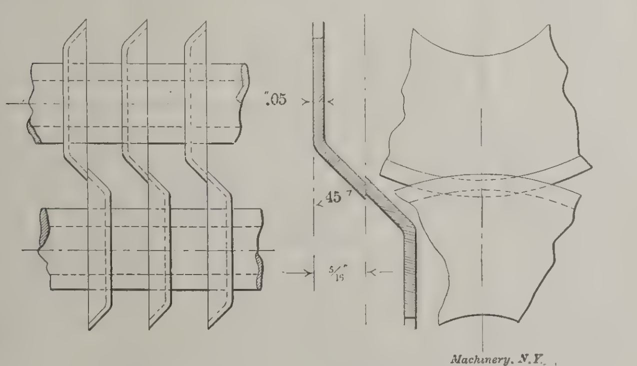
as shown in the sketch is designed to prevent this trouble. Supposing you are going to use a drill in the chuck and you want it to run true; adjust the rear end central with the jaws, then adjust the setscrews *A*, until the outer end runs true, and there you have it. If a piece of rod not long enough for the center rest, is to be turned or threaded, and the stock must run true, or if it is a finished piece, as a stud with the thread stripped, and which is not centered, this jaw will be very handy. On pieces such as the valve stem, *B*, which is to be repointed, or the bushing, *C*, which is to be babbitted and rebored, this jaw will be invaluable, as they must run very true. The surface by which they may be gripped is narrow and offers an insecure hold, and they are too fragile to allow of clamping very tightly. The device is handy for other similar pieces which have to be gripped at two places of different diameters. C. E. Burns.

Beverly, Mass.

DESIGN OF PAPER SLITTING CUTTERS.

A form of paper slitting cutters is here shown which has advantages that the usual styles do not possess, and therefore may be of interest.

They consist of a sheet steel stamping 0.05 inch thick and are so placed upon their arbors that they are always kept sharp by the cutting edges rubbing together. As the edges wear, the arbors are adjusted by a suitable means at each end. They are made of tool steel, but are not necessarily

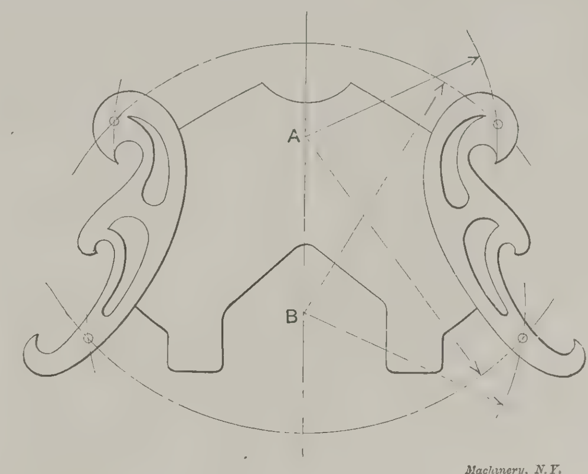


A Satisfactory Form of Paper Slitting Cutter.

hardened. Each set is placed on its arbor with the desired distance pieces between them, and the arbors placed in position on the machine in which they are to run. The machine is started up and the cutters grind each other. End movement for each arbor is provided to allow each set to come into contact. By this means it is evident that the cutters will run true and will need no further grinding, and will cut until they are worn cut, which in some cases has been over a year, although running every working day. Winamac.

TO DRAW SYMMETRICAL REVERSE CURVES.

In drawing a symmetrical figure which requires a right and left curved line some difficulty may be experienced, especially if a celluloid curve is used. By using a wooden curve, marks can be put on it to indicate the beginning and ending of the line desired, but doing this for some time puts the curve in a bad shape and it becomes hard to discern which mark was put down last. It is hard to put marks on the rubber or celluloid curves, so the following method of using curves of any material seems to be ideal:



Method of Drawing Symmetrical Reverse Curves.

As can be seen in the cut, there is a hole about 1-16 inch diameter put in each end of the curve. In use, the curve is laid on the drawing, the location of the holes marked with pencil point, and the desired curve drawn. On the center line of the piece to be drawn select two centers, as *A* and *B*, and from them locate the positions of the holes on the opposite side. Place the holes in the curve over these points and the curve is in the reversed position. The method is simple; in fact, it takes a much longer time to explain it than to follow it. Winamac.

CHUCKING PIECES FOR PLANER WORK.

The two chucking pieces for holding thin pieces on planers, shown by A. Fr. Bierbach in a recent number are very neat and useful, and are on the same general principle as those shown on page 155 of my "Work Shop Hints." I would suggest, however, instead of having two sets, one for through slots and another for so-called dovetail grooves, as shown by

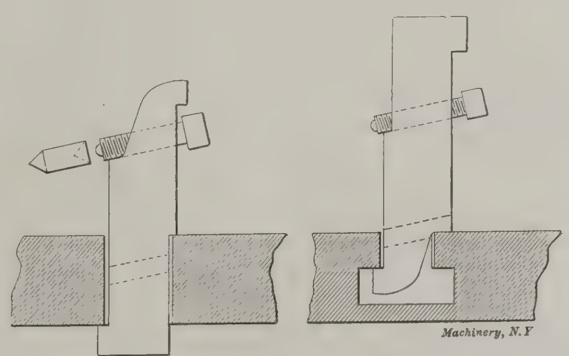


Fig. 1. Fig. 2.

Mr. Bierbach, combining the features of the two kinds in one double-ended device as shown herewith. Fig. 1 illustrates its use on a through slot and Fig. 2 the same device turned upside down for use with a dovetail groove. The screw-holes are to be drilled and tapped before the steps are planed in the pieces. Robert Grimshaw.

Hanover, Germany.

* * *

The copper production of the world amounted to more than 700,000 tons during 1905. The United States produced more than half, or exactly stated, 58 per cent of the total amount. Next to the United States comes Mexico as the largest producer of this metal.

SHOP RECEIPTS AND FORMULAS.

A DEPARTMENT FOR USEFUL MIXTURES.

This page will be used for the publication of shop receipts which the contributors know from experience to be practicable. Nearly all readers of MACHINERY can add something, and it is desired that they use this page as a medium for exchanging useful formulas. It makes no difference if they are old and supposedly well-known, provided they have not already appeared in this department.

240. CEMENT FOR LEATHER BELTS.

To make a cement for leather belts use gutta percha, 16 parts, pure white India rubber, 4 parts; dissolve, and then add pitch, 2 parts; shellac, 1 part; and boiled linseed oil, 2 parts. W. R. BOWERS.
Birmingham, Eng.

241. CEMENT FOR FASTENING GLASS WORK TO BRASS TUBES.

A cement for fastening glass work to brass tubes is made of rosin, 5 ounces; beeswax, 1 ounce, and red ochre or Venetian red, in powder, 1 ounce. W. R. BOWERS.
Birmingham, Eng.

242. SOLDER FOR SMALL PARTS.

To make a solder for small metal articles cut tinfoil into the shape wanted and wet on both sides with sal-ammoniac. Have the surface of the piece clean, place on it the wet tinfoil and then press the parts together firmly and heat until the tin-foil is melted. E. W. NORTON.

243. MIXTURE FOR EBONIZING WOOD HANDLES, ETC.

To prepare a mixture for ebonizing wood handles, etc., use logwood, 2 pounds; tannic acid, 1 pound, and sulphate of iron, 1 pound. Apply hot and polish when the pieces have become dry and cold. W. R. BOWERS.
Birmingham, Eng.

244. TO PREVENT SCALE IN HARDENING FINE DIES.

It is possible to prevent the formation of any scale in the impression of fine jewelers' dies and the like, and retain the finished brilliancy of surface, by applying a mixture of powdered ivory black and sperm oil, mixed to the consistency of paste. It is only necessary to apply a thin coat.
HARDENER.

245. TO CUT CORK.

In cutting cork, the knife is to be kept greased. Where, however, the desired piece is symmetrical about one axis, and of circular cross-section, it may best be roughed with a greasy knife and then ground to profile with a coarse emery wheel. Cork pen-holders are made in this way. Where many pieces are to be cut out of sheet cork, it is advisable to use a band knife, against which there is kept pressed a block of grease.
Hanover, Germany. ROBERT GRIMSHAW.

246. ARTIFICIAL SKIN FOR BURNS, ETC.

Dissolve equal parts of gun cotton and Venice turpentine in 20 parts sulphuric ether, dissolving the cotton first and then the turpentine. Keep in a tightly corked bottle. The use of the turpentine is to prevent pressure or pinching of the flesh caused by the evaporation of the ether when applied. Water does not affect this covering, hence its value for burns on the face or hands. E. W. NORTON.

247. PLASTER OR SALVE FOR USE IN PLACE OF STITCHES.

To make a plaster or salve which can be used in case of accident in place of stitches where a person has sustained a deep cut, melt together white rosin, 7 ounces; beeswax, ½ ounce; mutton tallow, ½ ounce. Pour into cold water and work with the hands until it is thoroughly incorporated, and roll out into suitable sticks for use. When required warm and spread upon a firm piece of cloth, cutting the wax into narrow strips in case of deep wounds. It will be found to hold the edges of the flesh firmly together.
E. W. NORTON.

248. TO HARDEN FINE DIES.

To successfully harden dies for fine work, such as are used by jewelers and others, be careful to have the surface free from all grease or oil, pack face downward in a mixture of equal parts of finely powdered hardwood charcoal and charred bone. Dip in salt water and draw temper to 450 degrees F.
HARDENER.

249. TO PREPARE TRIPOLI OR EMERY CAKE.

Tripoli, emery cake and crocus are all made in practically the same manner, the change being made in the composition when it is desired to have the composition more greasy. Melt tallow and paraffine wax or beeswax together. Beeswax is by far the best, but the cost of the same has led to the use of paraffine, which in many cases will work equally as well. After the tallow and wax are thoroughly melted, add tripoli or emery, whichever is to be made, a little at a time and stir in well, until it is as thick as is possible to make it; then pour out into a large tin, or better still into the moulds made for the purpose, and allow to cool.
Bridgeport, Conn. J. L. LUCAS.

250. TO CASEHARDEN A PIECE LOCALLY.

To caseharden part of a piece to a line or in a spot cover the part or surface to be hardened with a moderately heavy coat of black japan enamel. I prefer this as it bakes on more closely than anything else. Clean the work thoroughly, then put on a heavy coat of copper and the work is now ready to be carbonized, and is packed in a pot in bone or leather in the usual manner. Heat long enough to give the required depth of "case." Then take out of the fire and cool down in the pot. When cold reheat and dip in oil or water. The copper blocks the absorption of carbon while the japan burns off and allows the carbon in the bone or leather to be absorbed by the iron. E. W. NORTON.

251. TO TONE BLUEPRINTS.

After washing the blueprint in the usual manner immerse it for a half minute or less in a solution made by dissolving a teaspoonful of potassium bromide crystals in one-half gallon clear water. Then rinse the print in clear water and hang it up to dry. A galvanized iron or japanned tray may be used for the solution. Prints may be much overprinted and yet give beautiful clear whites and extremely deep blues, easily seen by the workman and a delight to the directors, the latter especially because the solution is quite inexpensive, and can be used over and over again until an objectionable precipitate forms. I have used this toning with Kueffel & Esser's paper and also with a number of local brands of blueprinting paper, all of which gave such fine results that we specify "all blueprints must be toned." F. J. SCHAUFELBERGER.
Denver, Col.

252. TO RECUT OLD FILES.

Brush the old files with a wire brush, put them in a tub, cover them with water and add 6 ounces of caustic soda per each 100 files. In about two hours brush them again. They will then be free of grease and metal. Then put them in a box, lined with sheet lead, on a wire stand made for the purpose, and in such a way that they will not touch one another. Cover them with a solution made of nitric acid and water, one pint of acid to each gallon of water. In 25 minutes remove them, wash them in water, brush them with a hair brush and put them back in the liquid to which one more pint of nitric acid to each gallon of water has been added. In about 50 minutes remove them again, brush them after washing them with water and put them back in the liquid to which has been added ½ pint of sulphuric acid per each gallon of water. In 15 minutes remove them; wash them first in water, then in concentrated lime water till all trace of the acid has disappeared. When dry they will have the appearance and cutting quality of new files. I used this method for recutting old files long ago and found it O. K., and so can recommend it. J. M. MENEGUS.
Los Angeles, Cal.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

23. F. O. B.—Why is it desirable to tin the interior of a box before pouring babbitt?

A.—Tinning a box is done so that the babbitt will adhere to it. Babbitt poured into a box without preliminary tinning will not amalgamate with the metal so as to form a permanent connection, even if hot, but by tinning the interior surface of the box the babbitt adheres as its heat is sufficient to melt the tin and permit amalgamation. Tinning, of course, is done with a suitable flux, usually chloride of zinc; and the use of a flux is not feasible when babbitting. Coating a box with tin is analogous to the use of cement.

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24. P. T. & S. Co.—What is the cheapest, best and quickest process for straightening steel plates, varying in thickness from ½ inch to ¾ inch, and varying in dimensions from 18 x 24 inches to 24 x 36 inches? These plates are not curved, but are slightly kinked, and must be reduced to practically a flat surface without being tooled, as a corrugated milling cut is to be taken across them.

A.—Probably the best method of straightening plates in a kinked or buckled condition is to run them between heavy rolls. In the absence of these the next best thing to do would be to pass them to a blacksmith shop equipped with a steam hammer and a surface-plate. A careful blacksmith with a heavy steam hammer having dies in good condition should be able to straighten the plates so that they would lie on the surface-plate with a variation of not more than 1/32 inch from a true plane. The question is submitted to our readers, some of whom may be able to give our correspondent the benefit of practical experience on a similar job.

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25. A. D. T.—Starting with none why is it necessary to make three surface plates in order to get one?

A.—It is necessary to make three plates for the reason that two plates cannot be depended on to correct one another's inaccuracies. For example, one plate might be high in the center and another low in the center, in which case an apparently perfect bearing might be obtained and still neither surface be a true plane. By having a third plate such a condition would be readily detected for it is impossible for the third plate to match *both* of the others. Given plates Nos. 1, 2 and 3, Nos. 1 and 2 are fitted together, and Nos. 1 and 3. Now, at this point all three may be out of the true plane and still match, but the moment that plates Nos. 2 and 3 are put together the inaccuracy will be apparent. If both are low in the center, as would be the case if fitted to No. 1 high in the center, they both must be scraped down an equal amount until a bearing is secured. Then No. 1 is corrected by fitting to both No. 2 and No. 3, and so on. In this way three perfect surface plates are necessarily produced in order to get one.

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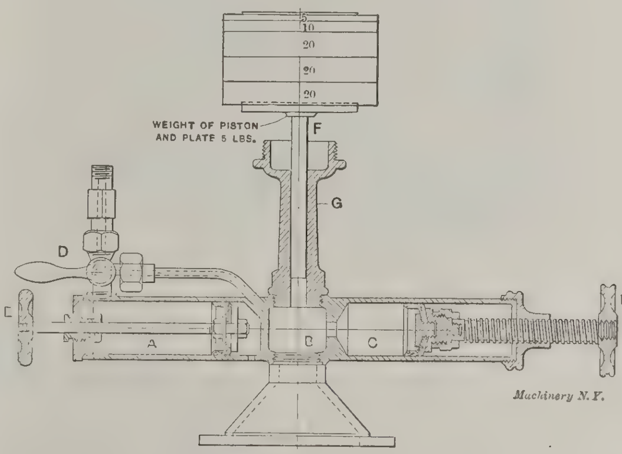
26. H. W. B.—An engine cylinder has six studs in the end and six nuts holding down the head; the nuts are tightened to a pressure equivalent to say 50 pounds per square inch, directly against the head of the cylinder. If steam is turned into the cylinder to a pressure of say 40 pounds per square inch, will there be a greater strain on the nuts with steam pressure in the cylinder than without?

A.—This is a question about which there has been a great deal of controversy. Broadly, for the case you specify, the admission of steam pressure into the cylinder would not increase the stress on the bolts. Suppose that a short section of spiral springs was placed under each of the six nuts and they were screwed down so that each spring pressed against the cylinder head with a pressure equivalent to 50 pounds per square inch on the sector of the head supported. Now, it is clear that the head cannot be pushed away from the end of the cylinder until the total pressure due to the springs is exceeded. Suppose, for clearness, that the diameter exposed to steam pressure is 6 inches; then the area exposed to steam pressure is 28.27 square inches and the total load imposed by the springs will be 1,413.5 pounds. The counter-pressure due to the steam pressure is 970.8 pounds; therefore the given steam pressure, or any internal pressure less than 1413.5 pounds could make no difference in the stress on the bolts. However, the foregoing answer applies only when the elasticity of the materials in compression is neglected. Suppose, for example, a perfectly elastic gasket is used between the cylinder head and the cylinder; then the internal pressure is added to the stress already existing in the bolts due to the compression of the gasket. Therefore, as cast iron and all materials are somewhat elastic it is evident that the broad answer given is not strictly correct, for the internal pressure does, in theory, add somewhat to the load on the bolts. The amount of additional loading depends upon the relative elasticity of the bolts and the surfaces in compression. If the bolts are long the amount of additional loading imposed on them due to the compression of the cast iron surfaces will be comparatively small.

* * *

A DEAD WEIGHT PRESSURE GAGE TESTER.

The American Steam Gauge and Valve Company have placed upon the market a testing apparatus for testing steam and other pressure gages which is reliable at all times owing to the fact that the pressure impressed upon the gage is obtained by weights. This apparatus is shown in sectional elevation in the cut. Its operation is as follows: The chambers *A*, *B*, *C*, are filled with a light oil, the gage to be tested is connected with the pipe leading up from the three-way cock *D*. This cock is then turned so as to connect *A* with *B*, and



Testing Apparatus for Pressure Gages.

handle *E* is pulled out so as to force oil from *A* into *B*, and into the gage, until the latter shows that there is some pressure acting upon it. Handle *D* is then turned to cut out cylinder *A*, weights are placed upon *F*, and handle *H* is forced in until piston *F* is lifted. If the gage registers correctly, its reading will agree with the weights on *F* + five pounds, this being the weight balanced by the piston *F* and its cap. To eliminate any error that may arise through the friction of *F*, the handle *H* can be moved in far enough to lift the weights some distance, and then it can be drawn out and the two readings thus obtained can be compared.

* * *

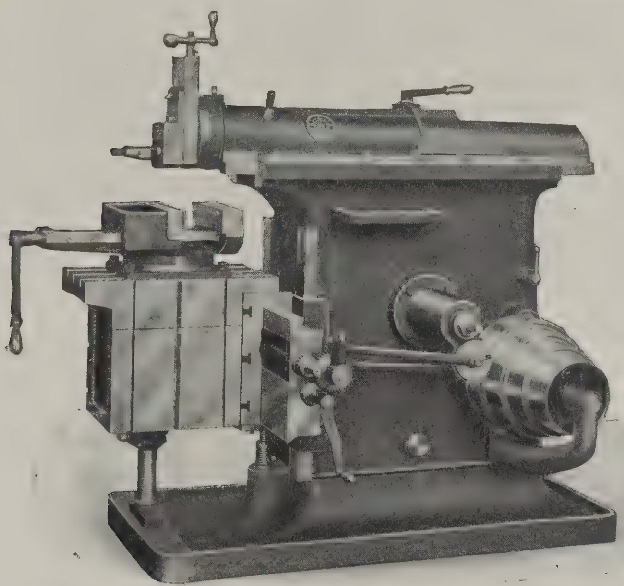
Some time ago we published a kink in regard to making typewriter copy from which clear blueprints can be taken. This is done by placing under the typewriter paper a sheet of carbon paper with the carbon side up so that in writing an impression will be made on the under side of the paper by the carbon, thus producing printing on both sides of the sheet. Blueprints from copy written in this way come out very distinctly and clearly. We have received a letter from Kearney and Trecker, Milwaukee, Wis., also explaining this method, but stating that in their practice it is used for much of the lettering on drawings, which are on bond paper. A typewriter with a wide carriage is employed for writing on the sheets. Much time is thus saved and the drawings have a neat appearance. It will take only a few minutes of any draftsman's time to try this as an experiment and it is believed the system will prove useful in any drawing office.

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

TWENTY-INCH ROCKFORD SHAPER.

The Rockford Machine Tool Co., Rockford, Ill., whose 16-inch crank shaper was illustrated in the New Tools column of the November, 1905, issue of MACHINERY, have placed a 20-inch shaper of similar design on the market. This is shown in the accompanying halftone. Among the special features of this make of shaper are a strongly reinforced column, an improved vise in which the screw pulls the jaws together instead of pushing them, a high back gear ratio, and the use of high-carbon steel, ground to size, for all the shafting. The base is of pan construction for catching all the chips, dirt, etc., and has a forward extension for table support. The feed rod adjusts itself to any height of the table and does not have to be changed when altering the vertical adjustment. The actual length of the stroke is 22 inches, the horizontal travel of the table 25 inches, and the vertical adjustment of table 14⅝ inches. The machine has a key-seating capacity of 3½ inches diameter, and the net weight of the machine and countershaft is 2,800 pounds. Further details of this design will be found by referring to the description in the November issue, previously mentioned.



Twenty-inch Rockford Shaper.

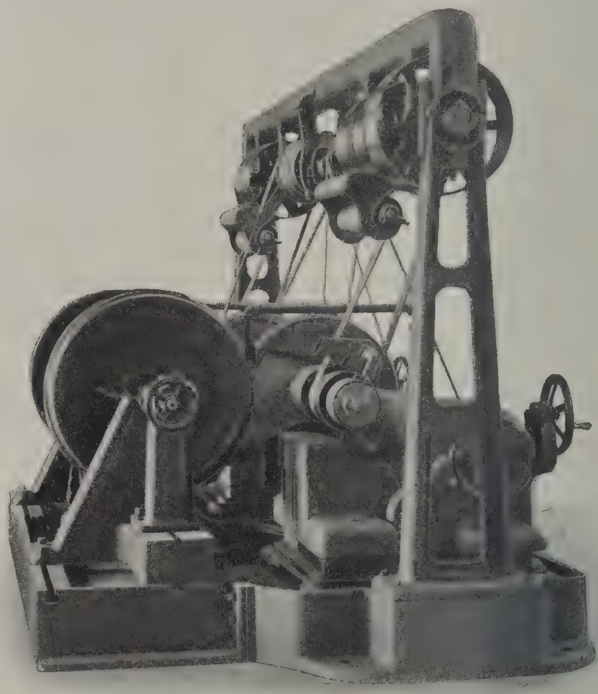


Fig. 2. End View of Norton Car Wheel Grinder.

NORTON CAR-WHEEL GRINDER.

The accompanying cuts show the general construction of a new car wheel grinding machine recently brought out by the Norton Grinding Co., Worcester, Mass.

The car wheels with their axle are driven by a worm and wormwheel near the center of the machine. The wormwheel is provided with a removable segment, and an opening is left in its journal in order to permit the axle to be placed in position. In order to eliminate the necessity of re-turning or re-grinding the journals and also for securing greater rigidity, the wheels revolve on their own journals. These rest at each end in half bearings of lumen bronze which are hemispherical on the external surface, and rest in hemispherical pockets. This latter arrangement permits a slight adjustment for worn wheel journals. In order to make further allowance for variations due to wear in the journals, the bottom of the bronze bearing is cut away, leaving only a small circular bearing at each side, which will act practically as a V-bearing. The journals are oiled automatically as they revolve by means of felt which is placed in the cut away portion of the bearing and saturated with oil. The stands carrying the bearings for the journals are movable in the longitudinal direction of the machine, thus being equally adapted for the support of axles with the journals inside or outside of the wheels.

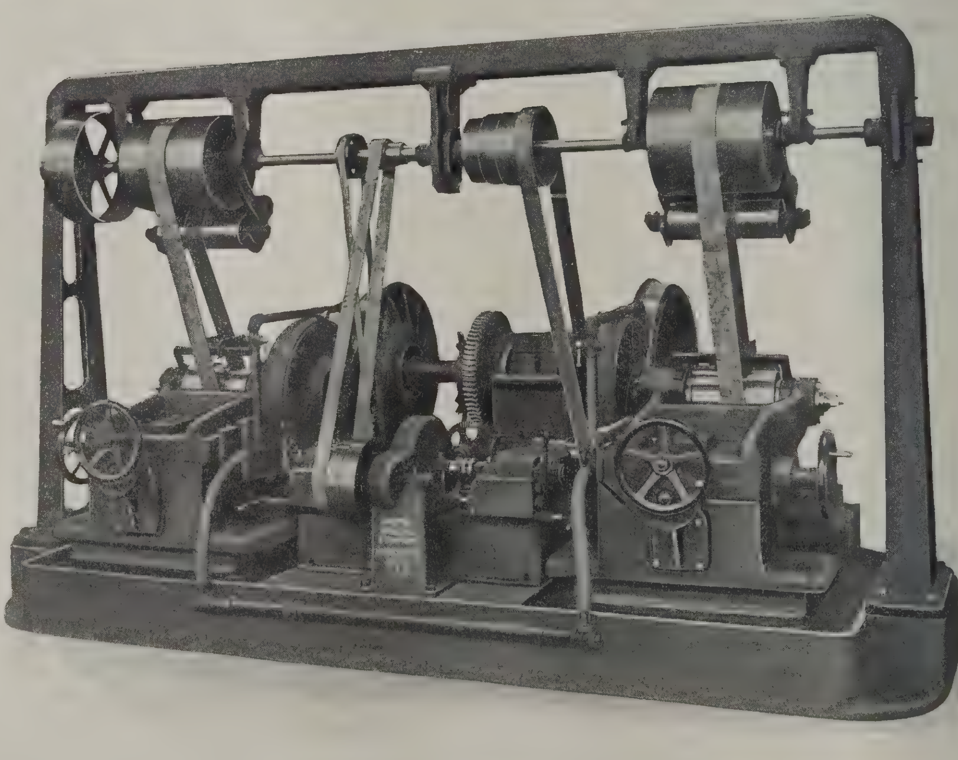


Fig. 1. Rear View of Norton Car Wheel Grinder.

The grinding wheels are 24 inches diameter, with a 2¾-inch face. They are mounted on wheel slides similar to those on regular grinding machines. The wheel slide is mounted on a slide moving parallel with the face of the car wheel, and this slide in turn is placed on a slide base which is pivoted to the bed of the machine, and permits the setting of the grinding wheel to the different angles required.

The slide moving parallel with the car wheel face is provided with automatic feed. It can also be moved for short distances by a handwheel. A special oiling arrangement is provided for this slide which will operate without attention

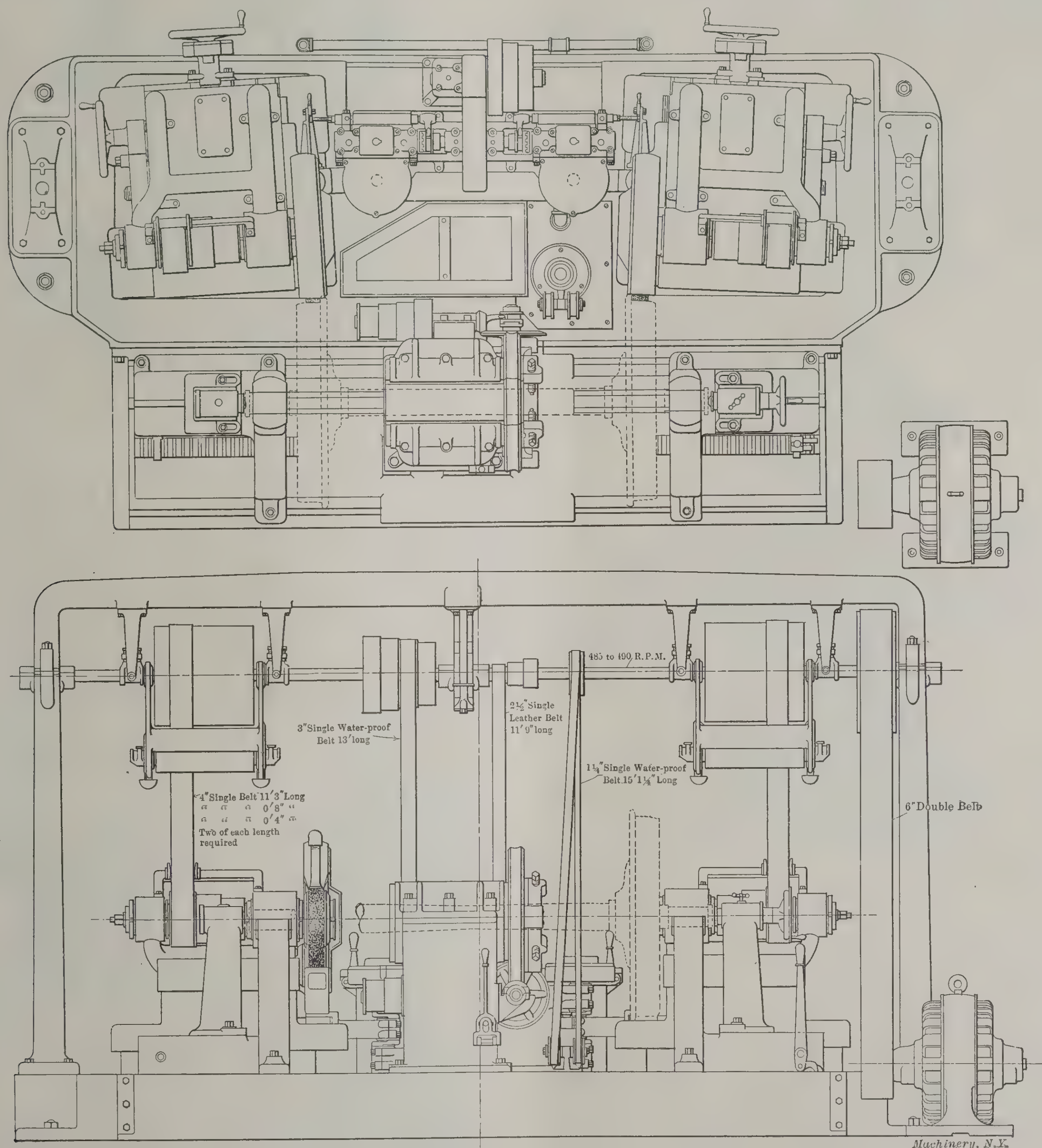


Fig. 3. Plan and Elevation of Norton Car Wheel Grinder.

for long periods. By means of clutches, one of which can be seen in the rear view of the machine, the slide can be moved, and by raising the handles shown in the same view near the water hose, the slide will be brought to stop automatically when in its extreme position toward the flange of the car wheel. This will prevent cutting into the car wheel flange after having thrown the clutch, provided the wheel was adjusted properly in relation to the flange before throwing in the clutch. At the same time, the operator cannot stop the traverse feed in any other position than the one indicated by the automatic stop.

The stopping and starting of the motion of the car wheels is accomplished by means of a lever between the wheels. The arrangement here permits, of course, the stopping of the worm wheel at the exact position, where, by means of removing the section referred to above, the axle can be put in place.

The machine has provision for water, and the base is so designed that all water is conducted to a removable settling tank. The supply is kept in a large water tank in the foundation under the machine, whence the pump distributes it to the wheels.

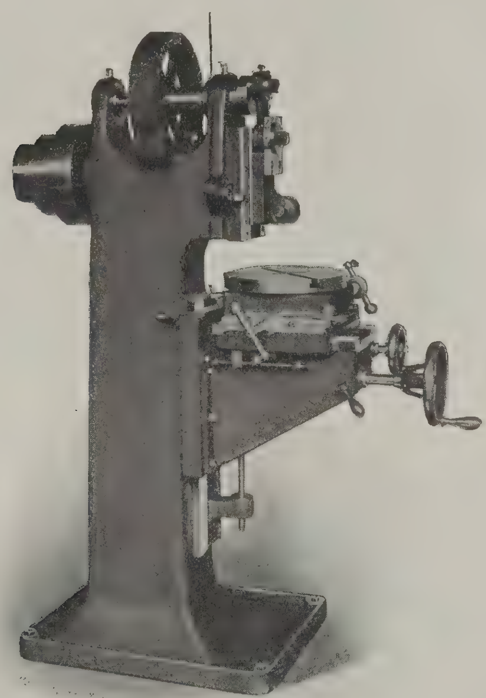
The overhead work is self-containing in order to permit a crane to pass over the machine for the purpose of placing the carwheel axles in, and removing them from, their bearings. The machine is furnished belted as shown in the cuts, and can be driven either from the lineshafts or by a motor. The latter should be a 30-horsepower motor of constant speed, and is shown in place in Fig. 3.

While car wheels have been ground in the past, the machines and devices used have been such as to produce far from accurate results. The present machine, however, is designed with the view of obtaining commercially accurate results, and will grind car wheels within a limit of 0.002 or 0.003 inch as far as roundness and concentricity is concerned. The machine is particularly rigid and weighs 30,800 pounds.

GARVIN DIE-SLOTTING MACHINE.

The Garvin Machine Co., Spring and Varick Sts., New York City, have rebuilt throughout from newly designed patterns the die-slotting machine which is one of the firm's oldest products. Among the changes introduced is the adoption of a solid extended type of knee similar to that used on the builder's line of milling machines. Hand wheels are provided to control the elevating and lowering of the knee and the in-and-out movements of the slide instead of the ball cranks formerly used, these wheels being provided with micrometer dials for reading the adjustments. Stops are also provided for the motion of the table and the slide.

The handle for the rotary table is arranged to use dials for dividing purposes, but for small divisions and rapid work the table can be revolved by hand, using the lock pin device, which gives twelve divisions. The ram is driven from a cone pulley through a reducing gear and has a fixed stroke of 2½ inches, which has been found suitable for the class of work generally performed on this machine; this allows a stronger pin construction than is possible when this part is made adjustable. The ram and the slide in which it is contained are adjustable 5 degrees either side of the vertical, the setting being read from a graduated index. The tool block is of a special shape well suited for holding special tools. It swivels on a



Garvin Die-slotting Machine.

center suitably located to give the proper action, and is rocked by a cam on the lower end of the connecting rod which locks the slide on the downward stroke, and relieves the tool on the upward movement. This machine, which weighs 1,150 pounds, is well adapted to the usual run of slotting, such as small straight or taper key seating, punch and die work, internal or external gear patterns, especially where draft is required; where intricate outlines have to be followed, the combination of the two cross motions and the rotary table provide means for doing almost any work of this character.

GORTON DOUBLE DISK GRINDER.

The Diamond Machine Co., Providence, R. I., who build the Gorton line of disk grinders, have recently added to that line the double disk machine shown in Figs. 1 and 2. The machine is built with two heads, one solid with the bed and the other mounted on the slide in such a way that the distance between their faces is adjustable to suit different widths of work, which may thus be finished on both sides to accurate dimensions.

This machine, which is known as the "6 K Gorton," is regularly furnished with 18-inch steel disks. That on the right-hand head is mounted on a spindle which can be given end motion by means of the handle at the extreme right of the machine. A micrometer stop is provided, reading to 0.001 inch, thus permitting work to be duplicated within very narrow limits. The bearings in which this spindle slides are especially designed to exclude all dirt and emery dust. Not

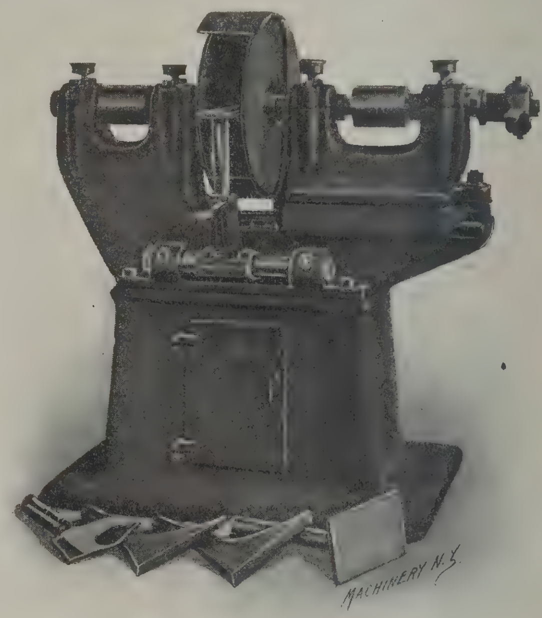


Fig. 1. Gorton Double Disk Grinder.

only is this head adjustable lengthwise of the bed for position, but it may be swiveled as well for any angle up to 10 degrees, so that tapering pieces may be ground as well as straight ones. When the removal of a large amount of stock is desired, emery rings, as shown on the floor at the right of the machine in Fig. 2, are used in place of the disks. Chucks for these rings are furnished at a slight extra cost.

The work is supported between the wheels by a table. These tables, of which a number are shown on the floor at the base of the machine in Fig. 1, are of varying widths to suit various sizes of work. The one at the extreme left is designed to hold thin circular pieces which may thus be finished on both sides at once. The bracket on which these tables are mounted, is

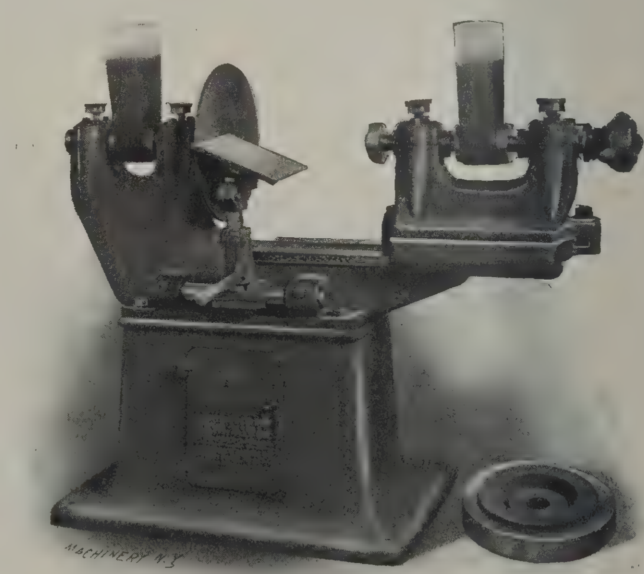


Fig. 2. Gorton Double Disk Grinder used as a Single Head Grinder.

swung about a pivot so as to move the work back and forth across the faces of the wheels. As shown in Fig. 2, the right-hand head may be moved out of the way or taken off entirely if desired, so, by using the adjustable table shown, the machine becomes for all practical purposes a single-head grinder of the usual type. Gages, studs, or jigs for holding irregular-shaped

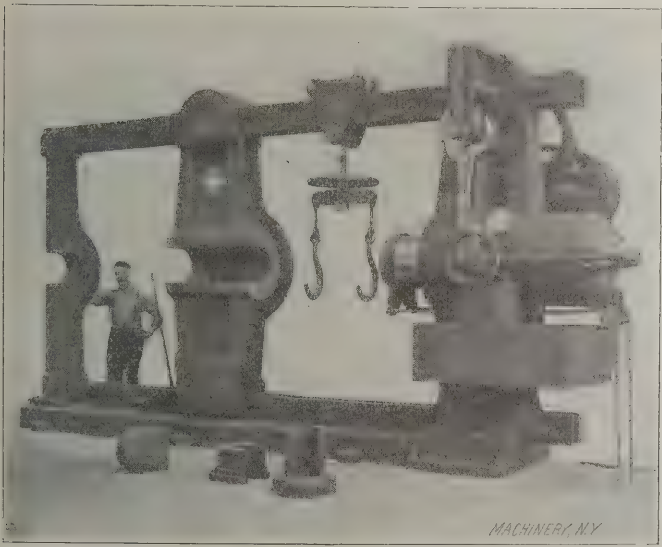
pieces may be fastened to the tables, thus greatly extending the range and rapidity of action of the machine.

The accessories furnished regularly with each machine are four 18-inch steel disks, six disk bolts and nuts, twelve assorted abrasive circles, one gallon of cement, one cementing press, three steel wrenches, four work tables, one adjustable table, one circular work table, and a double countershaft. The net weight with the accessories described above is 2,000 pounds. The machine will also be furnished with pedals in addition to the handles for operating the feeding movements when desired.

NINETY-INCH NILES 600-TON HYDRAULIC WHEEL PRESS.

The increase in weight of locomotives within the past few years has made changes necessary in railway repair shop equipment. This applies particularly to the hydraulic wheel press. Until very recently a hydraulic wheel press of more than 400 tons capacity had not been known, the usual equipment being of 300 tons capacity. Consequently many railway shops had found great difficulty in removing large locomotive drivers from their axles, especially in the case of steel centers with the tires in place. A wheel center forced on with a pressure of say 150 tons grips the axle with a greatly increased force when the tire has been shrunk in place. Often with the old equipment it has been necessary to remove the tires or to drill the hub in order to start the wheel center.

The accompanying illustration shows a 600-ton hydraulic wheel press recently placed on the market by the Niles-Bement-Pond Co. of New York. The distance between the ram and the resistance post is 8 feet 3 inches. The resistance post and the cylinder (which is one piece with its column) are steel castings. The outside diameter of the cylinder is 27 inches. Four tension bars are used to connect the two columns, and the resistance post is so arranged that its weight is entirely carried on the base-plate. The base-plate on which the press is mounted serves only to carry the weight, there being no stress transmitted to it since all pressure is taken by the tension bars. The cylinder is bored and lined with copper, expanded into place and burnished. The piston is packed with a cup leather in the usual form; it is counter-

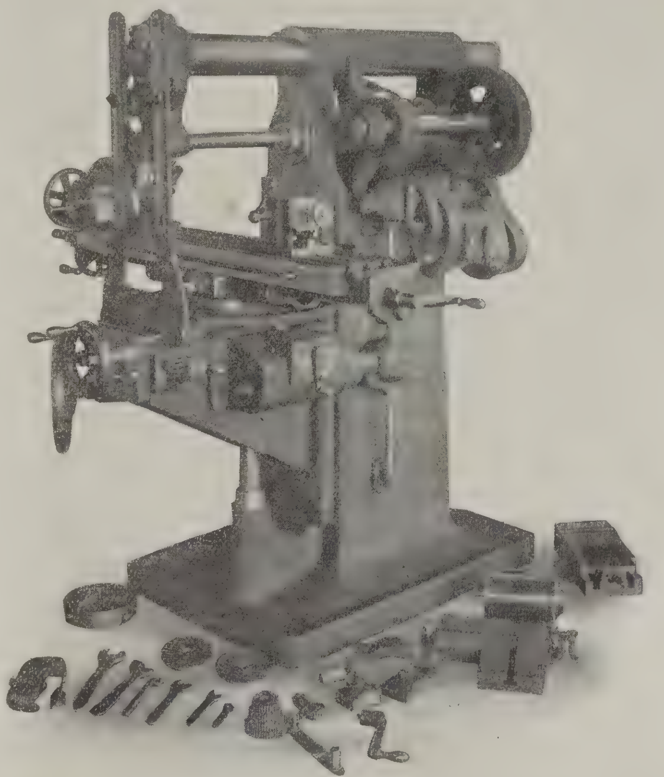


Ninety-inch Niles 600-ton Hydraulic Wheel Press.

weighted for quick return when the release valve is opened. A safety valve is provided which can be set to open at any desired pressure and is protected from tampering by a lock box. The pressure gage is graduated for tons of pressure and for pounds per square inch on the ram. The water tank is bolted to the post under the cylinder and takes the discharge and supplies the pump. The pump has three cylinders, the pistons of which are driven by a three-throw crankshaft and a 12½-horsepower motor is employed to operate it. The height between the tension bars is 90 inches and the machine will take wheels 84 inches in diameter on the tread.

THE OWEN NO. 2A UNIVERSAL MILLING MACHINE.

In re-designing their No. 2 universal milling machine to make it more suitable for use in taking heavy cuts with high duty steel, the Owen Machine Tool Co., of Springfield, Ohio, have added a number of improvements in mechanical detail. The telescopic shaft in the feed motion has been entirely dispensed with, the connection between the spindle and the feed screw on the table being entirely effected by positive gearing and splined shafts, no chain even being used between the spindle and the feed box. The rapid change gear mechanism used employs spur gears and straight steel clutches entirely, allowing the feed mechanism to be changed at all times when the machine is in motion without injuring it or any of the working parts. Thirty-two changes are obtained; four changes are controlled by the handle shown under the large back gear at the rear of the column; four are obtained in the gear box at the side of the knee controlled by a similar



Owen No. 2A Universal Milling Machine.

handle, while another lever on the knee gives still another change, making in all 4 x 4 x 2, or 32 changes. The ratio of feeds is arranged in geometrical progression.

The table has been given double bearing surfaces, the gears, spindles and arbors are made of forged steel, and the front spindle bearing in particular has been given great strength. All of these conditions tend to make the machine more rigid and suitable for the most severe service the tools used are capable of giving it. The knee of the machine has also been redesigned so as to effect a proper distribution of the material, which, with the increased weight given it, makes an exceedingly stiff construction at this point.

CYLINDER RING GRINDER.

The Graham Mfg. Co., Providence, R. I., have designed a grinding machine for finishing piston rings according to the method invented by Mr. Warren Chambers, of Toronto, Ontario. A description of this method was given in the April issue of MACHINERY (page 413 of the Engineering Edition). It will be remembered that with this machine the piston ring is dropped into a container of the same inside diameter as the cylinder in which it is to be used. The ring is shown in place in the container in the line cut Fig. 1, being represented by the heavy black area. The ring is revolved slowly by a projecting pin on the rotating dog in the center. Through an opening in the side of the container the face of the emery wheel is brought to bear on the outer surface of the ring which is here exposed to the action of the wheel. The great advantage of this system is that the ring is finished under exactly the same conditions that obtain when it is in place in the cylinder. With any other known method of finishing the periphery the ring will be found not to follow

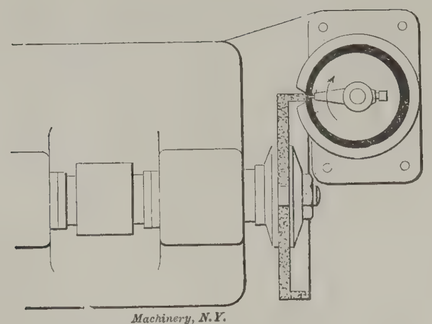


Fig. 1. Diagram of Action of Cylinder Ring Grinder.

exactly the contour of the cylinder, and hand fitting will be necessary if an accurate bearing is desired. For a further discussion of this subject the reader is referred to the article in our April issue.

Figs. 2 and 3 show the arrangement of the machine as designed by the Graham Mfg. Co. On the vertical column of the machine is mounted a head with a spindle carrying a cup emery wheel, whose edge is presented to the work in the manner shown in Fig. 1. From a small pulley at the rear of this spindle a belt is led to a large pulley at the base, which drives, through suitable gearing, the vertical shaft under the work holder. This vertical shaft, which drives the revolving dog, is furnished with universal joints as shown, in order that its upper end may freely follow the movement of the slide which carries the work. This slide may be fed in toward the wheel or brought back from it by means of the handwheel shown. The top of the slide is provided with T-slots for holding the various containers required for piston rings of different diameters. The rotation of the work may be stopped or started by means of the handle at the base of the machine.

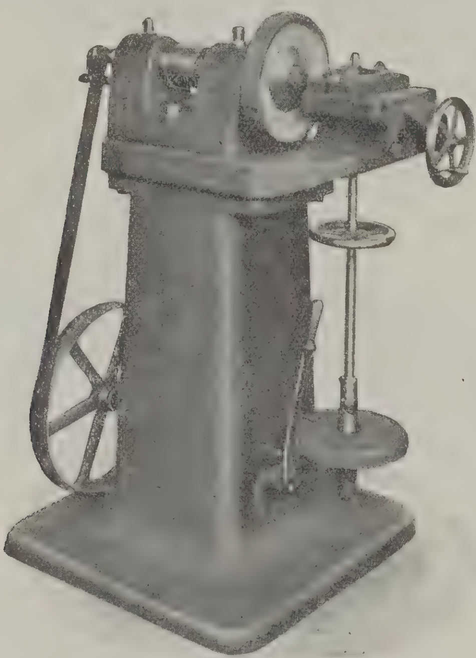


Fig. 2. General View of Cylinder Ring Grinder.

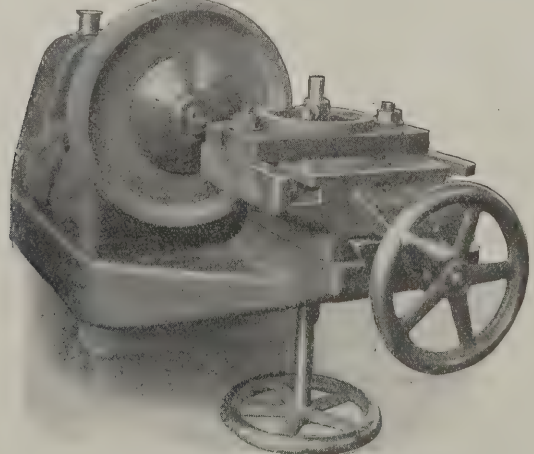
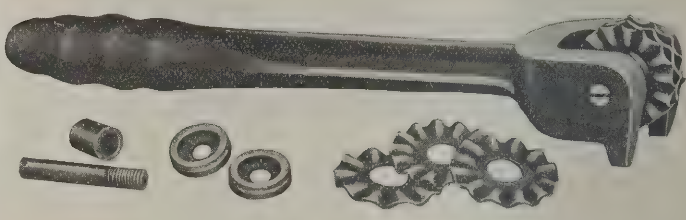


Fig. 3 Head and Table of Cylinder Ring Grinder.

SHERMAN EMERY WHEEL DRESSER.

An emery wheel dresser of new design, made by the Sherman Mfg. Co., Detroit, Mich., is shown herewith. The cutters, owing to the arrangement of the corrugations, always remain sharp until they are worn entirely away. Their life is lengthened by making them of a high grade of tempered tool steel. Each cutter is given a different number of corrugations, thus preventing them from "nesting" together and at the same time giving each cutter a different cutting edge. They are mounted on a bushing which revolves on a spindle, thus giving a better journal than is the case in dressers so designed that the disks revolve directly on the pin. Hardened concave washers are inserted between the cutters and the sides of the handle to prevent wear at this point.

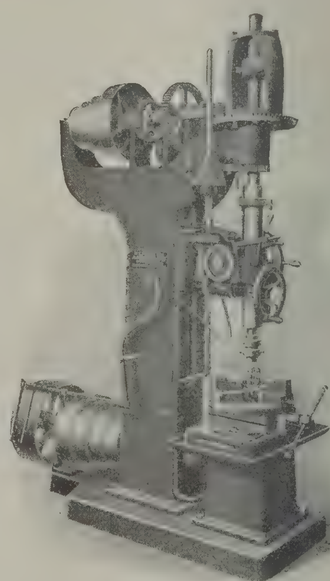


Sherman Emery Wheel Dresser.

THE MURCHEY IMPROVED TAPPING MACHINE.

The tapping machine shown in the accompanying halftone is built by the Murchey Machine & Tool Co., 33 to 37 E. Atwater St., Detroit, Mich. The machine consists essentially of a rigid cast-iron column supporting a vertical tapping spindle, with the necessary pulleys and gearing for driving it. It is especially designed for the rapid production of steam and gas pipe fittings, as well as for special work. Simplicity, strength, driving power and convenience of operation have been considered in designing it.

One of the most important of the improvements introduced in this machine is the means provided for transmitting rotary motion from the bevel gear to the tapping spindle. As will be seen from the cut, this is accomplished by a collar clamped to the upper end of the spindle and carrying two arms on which rollers are pivoted. These rollers travel on a surface provided for them on a casting clamped to the upper face of the bevel gear. The rotary motion is thus transmitted from the bevel gear through the casting to the rollers and the arm to which they are pivoted, which is in turn fast to the spindle. It will be noted that the bearing surface of the casting for the rollers is not vertical, but is inclined at an angle. This assures absolute ease of action in feeding a tap into the work, no matter how great a pressure may be needed to rotate it; this result cannot be obtained with the usual sliding key.



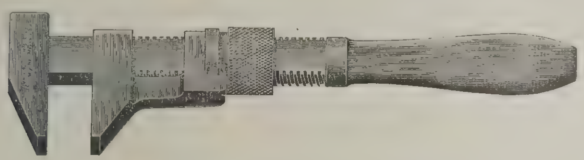
Murchey Improved Tapping Machine.

The table shown has a lateral and transverse adjustment which quickly and accurately centers the tap in a cored hole. This machine is not reversed to back the tap out, being provided with one of the builders' automatic collapsing taps, which have an adjustable stop arranged to come in contact with the sliding head which expands the chasers, and also causes the tap to collapse when it has reached the proper

depth. When desired, this machine will be furnished with a lead screw which may be made to fit any pitch of thread to suit requirements; it can also be fitted with a lever feed, hand feed, or power feed with automatic stop, according to requirements. The back gears and cone pulleys provided give eight spindle feeds. The machine shown has a range for tapping from ½ inch to 4 inches diameter inclusive. The builders are prepared to furnish special chucks for gripping flanges or fittings, and can furnish tapping machines for all sizes up to 12 inches diameter. Any suitable style of table can be furnished.

BEMIS & CALL STEEL NUT WRENCH.

The H. T. Bemis & Call Co., Springfield, Mass., have added to their line of wrenches the new design shown in the accompanying cut. The head bar and shank are made in a one-piece steel forging. The nut gives great gripping power to the jaws since as it has bolts or nuts which have the corners rounded off the whole hand can be applied for tightening the jaws of the wrench. Ordinary adjustments can be made with



Bemis & Call Steel Nut Wrench.

the thumb and finger. A special feature of this tool is the construction of the handle. It is made of steel and is forced onto the wrench under great pressure, then securely riveted in place. Being oval in form, it fits the hand and does not lame it in using as a straight handle will. It is adapted for use where the wooden handle wrench will not answer, as it cannot be injured by water, steam or heat.

* * *

A study of certain toys and mechanical devices put on the market to entertain or puzzle an audience is often of value to the mechanical designer. New applications of old principles are met with which may be profitably used to simplify a mechanism or to effect motions that would be difficult to secure otherwise. Suppose for example that it were desired to rotate a vane inside of a hermetically sealed case. If it were required that no opening be made through the side of the case the rotation of the vane would present seemingly impossible difficulties if the case were made of iron. The use of iron would, of course, prevent the use of magnetism so that about the only substitute for direct mechanical movement would seem eliminated but there still remains the possibility of using certain vibrations which, if properly applied, would rotate a light running vane under the conditions named with no mechanical connection whatever save that of the case itself. To illustrate, a little toy is sold by the street fakers called "Maz-zaz-zas," which is very mystifying in its action. It consists simply of a ½ inch square stick about 8 inches long having a nail driven in the end on which is suspended a light tin strip perfectly balanced and free to rotate. One corner of the stick is notched. The operator holds the stick in one hand while he rubs the notches with a match or toothpick, meanwhile pressing against one side of the stick with his moving thumb. The result is that the tin vane rotates rapidly in one direction. Now, if the pressure of the thumb is removed and pressure is applied by the forefinger on the opposite side of the stick the vane will commence rotating in the opposite direction. The explanation apparently is that the vibrations induced by the rubbing of the match together with the pressure of the thumb on the side of the stick causes the end of the stick to vibrate in a minute circular path which motion is communicated to the vane causing it to rotate. That these peculiar vibrations can be duplicated mechanically there is no doubt, hence the possibility of producing rotary movement of a vane in a hermetically sealed case with no mechanical connection thereto, save that of the case itself.

* * *

The fifth annual convention of the National Machine Tool Builders' Association will be held in New York, Oct. 9 and 10.

INDUSTRIAL NOTES FROM GERMANY.

Fifty Years Anniversary of the Society of German Engineers.—On June 11, 12 and 13, the Society of German Engineers held their 47th general annual meeting at Berlin and combined therewith the fiftieth anniversary of the society. Engineering societies from all parts of the world had sent representatives to express their hearty wishes. The American Society of Civil Engineers was represented for its members by Professor K. E. Hilgard of Zurich, who addressed some hearty words to the assembly. He referred to the International Engineering Congress of 1893 in Chicago as one of the most important meetings between German and American engineers. Both before and ever since this date American engineers have reaped much benefit from German science, German research and German skill. He then welcomed in the name of the American Society of Civil Engineers and all other American engineering societies all German engineers coming to the United States, and expressed the hope that the friendly relations between German and American engineers might always increase to the benefit of humanity. He closed with *a vivat, crescat, floreat* for the Society of German Engineers.

In course of the following days various interesting papers were read, of which we will only mention those of Professor Riedler-Berlin: "On the Development of Steam Turbines and their Importance at the Present Day" (a critical review on the various existing types of steam turbines, *Zeitschrift des Vereines deutscher Ingenieure*, 1906, Nos. 31, 32); Mr. O. Lasche: "The Construction of Steam Turbines by the Allgemeine Elektrizitätsgesellschaft in Berlin" (details on the various types, modes of construction, etc. *Zeitschrift des Vereines deutscher Ingenieure*, 1906, No. 33); Professor A. Rateau, Paris: "On the Rateau Steam Turbine (details on the Rateau steam turbine and the Rateau exhaust steam accumulator, *Zeitschrift des Vereines deutscher Ingenieure*, 1906, Nos. 37, 38).

Experiences and Tests with High-speed Drills in Railway Workshops.—By Government Works Manager Seiler, Berlin. The author expresses his surprise that high-speed tools, which have been extensively introduced in private industries, have not found the same reception in government workshops. His purpose is to show the advantage the use of such tools, and particularly high-speed drills in government railway workshops will afford. The reason why high-speed tools have not been successfully introduced in railways works he ascribes to the fact that the tools are generally made at the works themselves, where in consequence of the forging heat and owing to the lack of suitable tempering furnaces a great deal of hardness of the high-speed steel is again lost.

In order to prove the actual advantages of such high-speed steels he made various tests with high-speed steels from different manufacturers, which, however, with the exception of the Phœnix steel of Bleckmann in Steiermark were neither very successful nor satisfactory. Of this steel drills both pressed and drop-forged were employed, the latter, however, proving to be an entire failure, as they were much too soft. The results of the trials with pressed drills made of Phœnix steel are given in the following table:

Number	1	2	3	4
Revolutions per minute	103	165	200	200
Diameter of drill	3/8	5/8	3/4	3/4
Material drilled	Cast-iron brake-shoes.		Tool steel	
Duration of test, seconds	220	170	485	250
Depth of hole, inches	3 3/8	3 3/8	8	8
Speed of feed	15/16	1 1/4	1	1 15/16
Remarks	Drills not weakened, but belt slipped.		drill began to break out at edge.	

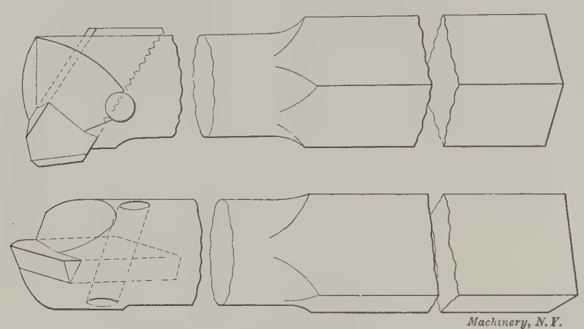
A drill made of ordinary steel, being subjected to the same tests was blunted after only a few revolutions.

The tests with the other steels were not all satisfactory for reason of inferior quality of the steels; occasionally also the machines on which the tests were made were not strong enough, or the power at disposal not great enough to allow of obtaining the full capacity of the tools. This also might frequently be the reason why customers complain of not having been able to obtain full satisfaction with the steel.

At a later series of tests the author was able to obtain a feed of up to 3 inches with a ⅞-inch drill running at 260 R. P. M. in wrought iron, the test being, however, terminated by the tool splitting up. Such splitting of the drills he ascribes to the feed limit being exceeded and fears steel manufacturers frequently claim too high capacities for their high-speed steels only to beat competition.—*Glaser*, 1906, Vol. 59, No. 2, 4.

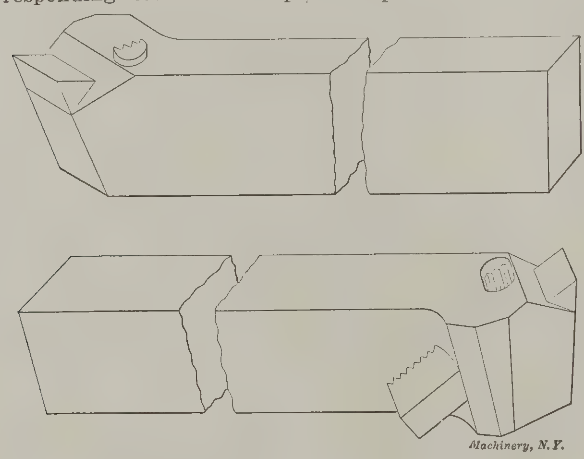
Machine Tool Trade in Germany.—Extraordinary activity exists among German manufacturers of machinery and machine tools. Various great iron works, ship-yards and other establishments are increasing their plants; also, the export trade to Russia is not so bad as might be expected under the present conditions. Great hopes are, however, entertained as to the expected increase of trade, when Russia calms down at last. Germany exported to Russia from March to June, 1906, machine tools to the amount of 8,350 pounds. This figure is very low compared with the figures of 1905-1903, viz.: 92,000, 72,000, 64,000 pounds respectively; or even compared with the export in January and February, 1906, viz.: 30,000 pounds, the figure is low. The reason is the increased duty on machine tools imported into Russia.

Tool-holder.—A new high-speed cutting tool-holder has been patented by Messrs. Mummenhoff & Stegemann of Bochum. The holder is made of very tough forged steel in the form of



Mummenhoff & Stegemann Inserted Cutter Boring Tool.

a cutting tool and encloses the cutter proper so entirely that the latter appears to be welded into the holder. The cutter has a rack-line set of teeth on its side into which engage the corresponding teeth of a taper lock-pin. As the cutter is



Mummenhoff & Stegemann Inserted Cutter Turning Tool.

closely and entirely enclosed by the holder the heat produced by cutting will readily pass over into the holder. On the cutter wearing down it can be advanced tooth by tooth.

International Motor Car Show, Berlin, Autumn, 1906.—A fine new building has been erected in the Hardenbergstrasse along the Berlin Zoological Gardens, intended to serve as hall for periodical exhibitions, etc. It will be inaugurated on November 1, 1906, on occasion of the festival opening of the Autumn Motor Car Show, 1906. This show has been arranged to last from November 1 to November 12, thereby enabling exhibitors to visit the London and Paris shows following. Emperor William II., who like his brother, Prince Henry, has a lively interest in motoring, has promised to be present at the opening. 13,000 m^2 covered, and 2,000 m^2 uncovered area is at disposal for exhibition purposes in these new premises.

The well known machine tool works of Ernst Schiess of Düsseldorf, have been converted into a limited company. The principally concerned are the Deutsche Bank and the banking firm, C. G. Trinkhaus of Düsseldorf. The capital of the new firm amounts to 5,500,000 marks, of which 3,500,000 marks will be invested in shares.

Benz & Co. Rheinische Gasmotorenfabrik, Aktiengesellschaft, Mannheim, are intending to extend their works, thereby meeting a long-felt want. No definite decision has as yet been made as to the site of the new premises.

Messrs. Thyssen & Co., of Mühlheim o/Ruhr (Germany), have purchased about five acres of land in addition to the area already covered by their works. They intend to take up the manufacture of locomotives as a specialty.

Concordia Elektrizitäts A-G. Cologne-on-Rhine (Germany): Under this name a new concern has been established with the purpose of erecting electric power stations and plants.

Berlin, September 15, 1906. D.

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OBITUARY.

William H. Owen, formerly president of the Owen Machine Tool Co., Springfield, Ohio, died at his home in that city August 31.

James A. Burden, the well-known ironmaster and inventor of Troy, N. Y., died at his New York home September 23. He was born in 1833 and was the son of Henry Burden, the inventor of the horseshoe machine.

William F. Kennedy, who is said to be the inventor of the base burner radiator stove with shake and dump grate commonly used for heating rooms, died a few months ago in Providence, R. I., at the age of 82.

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PERSONAL.

Erik Oberg, for the past three years draftsman in the small tool department, Pratt & Whitney Co., Hartford, Conn., has joined the editorial force of Machinery.

A. L. De Leeuw is engineering the new plant to be erected by the Cincinnati Milling Machine Co. at Oakley, Ohio, a suburb of Cincinnati.

Mr. and Mrs. Amos Whitney celebrated their golden wedding September 8 at their residence, No. 568 Farmington Ave., Hartford, Conn.

Arthur W. Cole leaves the University of Maine to act as instructor of steam engineering for the coming year at Purdue University, Lafayette, Ind.

Mr. M. Koyemann, the representative for Northern Europe of the Jones & Lamson Machine Co., the Fellows Gear Shaper Co., and other American manufacturers, is in this country and expects to stay until the latter part of October.

T. E. Barker, for ten years with the Miehle Printing Press & Mfg. Co., Chicago, Ill., in various executive positions, has resigned to accept the position of superintendent with the America Co., hardware specialty manufacturers, Momence, Ill.

Edward R. Markham, 66 Dana St., Cambridge, Mass., a well-known contributor to Machinery, is now giving up part of his time to consulting engineering practice, making a specialty of advice on hardening, tempering and annealing steel, and general shop work.

Thomas M. Brown has taken charge of the machinery department of the William Skinner Shipbuilding & Drydock Co., of Baltimore, Md. Mr. Brown had been identified with the machinery trade for many years, but for the past two and a half years was in another line of business. His friends will be pleased to learn of his return to his former work.

Wm. A. Bole, for many years superintendent and works manager of the Westinghouse Machine Co., East Pittsburg, Pa., has been made consulting engineer of that company, and vice-president and general manager of the Westinghouse Consolidated Foundries Co. This concern, located at Trafford City, about five miles from East Pittsburg, will do all the foundry business of both the Westinghouse Machine Co. and the Westinghouse Electric & Mfg. Co.

FIRE EXTINGUISHER FOR MARINE COAL BUNKERS.

One of the most difficult things to combat on board ship is fire in the coal bunkers. Bituminous coal containing iron pyrites is likely to become on fire by "spontaneous" generation of heat sufficient to cause ignition. When fire is discovered in stored coal the common impulse is to fight it by pouring streams of water upon it but this is generally ineffective. A smouldering fire at the bottom of a coal pile forms a mass of coke around it which will not permit the entrance of water in sufficient quantity to drown out the fire, but the heat will change the water to steam and then to water gas which if confined in close places like the hold of a ship is likely to form explosive mixtures. Prof. Vivian B. Lewes suggests that a valuable and effective fire fighting apparatus for coal bunkers would be carbon dioxide stored in strong steel cylinders provided with a fusible plug. Carbon dioxide compressed to liquid state requires a pressure of 1,700 pounds per square inch, and when it expands it produces intense cold, and is also a non-supporter of combustion. In case of fire in the vicinity of one of these cylinders the combustion would be stopped by the reduction of temperature as well as the absence of oxygen. One hundred cubic feet of carbon dioxide can be condensed in a liquid state in a steel cylinder having a capacity of about 7 cubic feet. A ton of average coal contains about 12 cubic feet air space so that one of these cylinders should be put in for every 8 tons of coal in order that the carbon dioxide gas would be sufficient to displace all the air within the coal mass.

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FRESH FROM THE PRESS.

THE Machine Tool Pocket List formerly published by Angus Ballard Co. has been purchased by the Geo. H. Gibson Co., Park Row Building, New York. The size of the publication will be increased from 3½ x 6 inches to 4 x 9 inches. The buyers' finding list of machine tools and supplies will be made still more complete and definite. Brief articles of interest to manufacturers of machinery will also be added and the list will be combined with *Manufacturing*, a journal published by the Geo. H. Gibson Co., which describes and lists important patents and other industrial opportunities.

THE MCCONWAY & TORLEY CO., Pittsburg, Pa., have recently issued a new edition of the "Car Interchangeable Manual," covering all decisions of the Arbitration Committee from November, 1888, up to and including case No. 703 of May, 1906. They are making a general distribution of this book to railway car men, but any who have not received a copy may obtain it free of charge on request. The McConway & Torley Co. have also issued a pamphlet entitled "Ready Reference Tables," designed particularly for car men, and they now have in press a new edition of "Catechism of M. C. B. Rules." Any or all of these books will be sent to railway men free of charge.

CATECHISM ON PRODUCER GAS. By Samuel W. Wyer. 42 pages, 4¼ x 6½ inches. 3 cuts. Published by the McGraw Publishing Co., New York. Price, $1.00 net.

This timely little book is gotten up in the familiar catechism style popular for instilling elementary knowledge on engineering subjects. It contains a considerable amount of information on producer gas, its manufacture, the apparatus employed, etc. The subject is one which is rapidly becoming more and more important. The gas producer plant and the gas engine are quite likely to displace the steam power plant, wherever economy is a prime requisite. As a primer or introduction to the subject, this little work can be recommended.

WIRING A HOUSE. By Herbert Pratt. 21 pages. 5⅛ x 8 inches. 6 cuts. Published by the Derry-Collard Co., New York. Price, 25 cents.

This little book is No. 6 of a series of practical papers published by the Derry-Collard Co., and is written by one who has had much experience in the planning of wiring and the actual wiring of houses and other buildings. It is chiefly devoted to the wiring of houses already built which, of course, is a much more serious job than the wiring of new houses. The necessary calculations for obtaining the sizes of wire are given and other practical information which should be useful to those contemplating the doing of such work.

HELPFUL HINTS FOR HARDENING STEEL. By Jos. W. Bennett. 83 pages 3½x5 inches, 12 cuts. Published by the author at New Britain, Conn. Price $1.00.

The author has had thirty-five years' experience in hardening and tempering tool steel and should, therefore, be in a position to give some good practical hints to other workers of tool steel. A number of the hints given could easily be worth many times the cost of the book to some steel workers. Following are a few of them: How to anneal steel containing hard and soft spots; how to harden blanking dies; how to harden a drill jig or reamer bushing to prevent shrinking; how to harden spring collets; how to prevent taps from shortening in the lead, etc. The author includes a coupon in each book which entitles the purchaser to the privilege of asking questions from time to time concerning hardening and tempering steel, a feature that doubtless will be appreciated by some purchasers.

THE AMERICAN STEEL WORKER, by E. R. Markham. 366 pages, 5½ x 7¾. 163 cuts. Published by the Derry-Collard Co., New York. Price, $2.50.

This is the second edition of Mr. Markham's excellent work on the working, hardening and tempering of the various kinds and grades of steel. It is doubtless the best practical work on the subject for the smith, toolmaker and general mechanic. The second edition has been improved in a number of ways. It is printed on thinner paper, making the volume more compact, and an appendix of 24 pages has been added on high-speed steel. An excellent feature of this work which cannot be too highly commended is a copious index of contents, this part covering 28 pages. The value of a complete index to a work of this kind can scarcely be over-estimated for its chief value lies as much, perhaps, in being a work of reference, as for the general information to be obtained by one reading, and the index is an important time-saver.

DESIGNS OF SMALL DYNAMOS AND MOTORS. By Cecil P. Poole. 186 pages 6 x 9 inches, 231 cuts. Published by the McGraw Publishing Co., New York. Price, $2.00 net.

This book is designed for the amateurs and others who desire to build small electrical motors. Most of its chapters were originally articles published in the *American Electrician*. The book gives directions, with sketches, for building a 1-6 horse-power motor with drum armature and with ring armature and the same designs for ¼ and ½ horse-power; also for 1 horse-power bi-polar motor and four-polar motor with drum armature; 2 horse-power four-polar motor with two-path drum armature; direct current 110 volt motor; three horse-power launch motor, etc. The designs and sketches have, we believe, been verified by actual construction, so that they are, for the most part, reliable guides for the amateur builder. Perhaps one of the best ways of getting the elements of electrical science well grounded is to construct some simple electrical apparatus like examples shown in this work and to such this book should appeal.

BRAZING AND SOLDERING. By James F. Hobart. 33 pages, 5½ x 8 inches. 16 cuts. Published by the Derry-Collard Co., New York. Bound in paper. Price, 25 cents.

This little book is No. 5 of a series of practical papers, and it should meet with general approval, being on a subject on which there is more or less general demand for "pointers." It treats of soldering, hard and soft, that is, brazing with spelter and soldering with the tin and lead solders. The author has had much practical experience in this class of work and he has illustrated the text with sketches which show plainly the various tool and methods employed. Hard soldering, or brazing, is one of the most useful methods of making sound joints, and next to welding, is the strongest. But, unlike welding, it is applicable to a considerable class of metals either similar or dissimilar; as, for example, brass to brass, or brass to iron, and so on. In the chapter on soldering various forms of soldering bits are illustrated and the correct method for taking solder from a bar. We have no doubt that amateur users of a soldering kit can learn a number of useful hints by reading this little work.

COMPLETE EXAMINATION QUESTIONS AND ANSWERS FOR MARINE AND STATIONARY ENGINEERS, by Calvin F. Swingle. 367 pages, 4¼ x 6¾ inches, 212 cuts. Published by Frederick J. Drake & Co., Chicago, Ill.

As indicated by the title this book is of the familiar and popular catechism type in which questions are proposed and answered in a succeeding paragraph. This form of technical literature appeals to the firemen, engineers, and those who are required to pass an examination in order to obtain a license. It formulates the question and a presumably accurate answer thereto in a way which is concise and to the point. The book in review appears to be a fair example of this class. It covers a considerable range and must necessarily be more or less superficial when the available space is considered. It touches on steam, heat, combustion, fuel, boilers, boiler construction, boiler settings and appurtenances, boiler operation, types of engines, condensers, pumps, sea-water, auxiliary machinery and fittings, the indicator, principles of the indicator, the steam turbine, etc. The cuts are a collection of wood cuts, zinc etchings, and halftones, and are in many cases of a totally disproportionate size to the page and subject. The book, on the whole, is one that will doubtless be of considerable benefit to the class for which it is designed.

HANDBOOK OF MATHEMATICS. By J. Claudel. Translated and edited by Otis A. Kenyon. 708 pages 6 x 9 inches, 422 figures. Published by the McGraw Publishing Co., N. Y. Price, $3.50 net.

The original of this book is a French work intended for engineers and engineering students and the translation is from the seventh French edition. It is intended primarily as a reference book, but it is also well adapted for home study. The translator says in the preface: "The use of text books for reference by the busy man is discouraging. For example, if he wishes to solve an integral which is not given in the table he naturally refers to his text book on integral calculus, spending several hours studying, and then finds that his trouble is farther back, most likely in algebra. The chances are that due to lack of time he will give up and declare that he has forgotten his calculus." In the preparation of this work the trouble mentioned has been anticipated by the very frequent use of cross references, completely interconnecting all parts of the book. The book is divided into six parts, as follows: Arithmetic, Algebra, Geometry, Trigonometry, Analytic Geometry, and Elements of Calculus. From a somewhat superficial examination of the work it appears to be one that almost any engineer would be glad to have on his book shelves to occasionally refresh his knowledge of mathematics. It is well gotten up, the type being large and clear, formulas distinctive, and the tables well arranged.

TECHNICAL DICTIONARY, Vol. 1. By K. Deinhardt and A. Schlomann. 403 pages, 4 x 7 inches; illustrated. Published by the McGraw Publishing Co., New York. Price, $2.00 net.

The scheme of this dictionary, which is to be published in eleven volumes and in six languages, is to present (if possible) a sketch of the thing named in the middle of the page and to give its name in English, German, French, Russian, Italian and Spanish, in parallel columns one at each side. The dictionary presents three distinct features: 1, index; 2, systematic arrangement of matter; 3, alphabetical index of words. For example, in the division Screws and Screw Bolts, the first sketch shows a helical line around a cylinder. This is defined in the six languages, then follow "angle of inclination, "pitch," "helicoidal surface," "thread of screw," "the screw has *x* threads per inch," "screw-thread," etc. It is, of course, obvious that certain ideas cannot be represented by sketches, so that each definition does not necessarily have a sketch to accompany it. The general arrangement of the work makes its use very convenient. Vol. 1 is on the elements of machinery and the tools most frequently used in metal and wood-working. Among the machine elements are listed Screws and Bolts; Keys, Rivets, Axles and Shafts, Trunnions, Bearings, Lubricators, Couplings, Gearing, Friction Wheels, Belting, Chain Transmission, Rollers, Ratchet-gearing, etc. Under the general head of tools we have Vises, Tongs, Anvils, Hammers, Chisels, Files, Scrapers, Drills, Milling Cutters, etc. The scheme of illustrating each machine part, etc., by means of sketches, which is a universal language understood by all, makes the work one of great general value and one to be commended to the needs of those having to make technical translations.

THE DESIGN AND CONSTRUCTION OF CAMS. By Chas. F. Smith, Frederick A. Halsey and others. 70 pages, 9 x 12 inches. 62 cuts. Published by the Hill Publishing Co., New York. Price, $3.00

This book is largely a reprint of the articles on cams that have appeared in the *American Machinist* during the last year or two, and which undoubtedly constitute one of the best treatments of the subject to date. Mr. Smith, the principal author, has been connected with the construction of machinery involving the use of cams for twenty-five years, and naturally he has made the study of cams a specialty. When it is known that he has designed machines containing as many as twenty cams, all of which were laid out and keyseated from drawings and assembled without change, working in entire harmony, it must be admitted that his system is one that gives correct results. The book by chapters is as follows: Classification of Cams in Order or Work; the Machine from which the Illustrations are Drawn (being a wire chain-making machine); the Operation of the Chain-Making Machine; Charting the Movements; Laying out an Actual Face Cam, Making the Former and Milling the Cam; Laying Out and Making Periphery Cams; Raised Pathway, Yoke and Conical Cams; Cams for Prescribed Movements; Repeated and Return Movement Cams; Charts with a Separate Base Line for Each Cam, Abbreviated Charts, Extreme Angles, Locating Keyways; the Double-Cam System of the Monotype; Cam Movements Obtained from Base Curves Other Than the Circle; the Location of Lever Fulcrums for

Face Cams; Minute Adjustment of Cam Lever Movements; Grinding Cams. The size of the page (9 x 12 inches) permits the use of large drawings, but even with this size page it has been necessary to introduce one folding chart, being the cam chart of the chain-making machine. Altogether, we can recommend the book as being a first-class work on a technical subject in general little understood.

NEW TRADE LITERATURE.

Fitchburg Machine Works, Fitchburg, Mass. Supplementary booklet on the Lo-swing Lathe, giving some details about the machine and instructions for its operation.

Atlas Engine Works, Indianapolis, Ind. Bulletin No. 132 describing medium speed automatic four-valve engines and their various parts and giving tables of specifications for the different classes.

Crocker-Wheeler Co., Ampere, N. J. Bulletins 66 and 67, taking for their subjects Form I-F Variable Speed Motors and W Motors for Rolling Mills, respectively. The usual description, illustrations and tables of specifications are included.

Modern Tool Co., Erie, Pa. Catalogue describing and illustrating their various tools—chucks, tapping attachments, dies, grinders, etc. Tables of U. S. Standard bolts and nuts, drills for U. S. S., V., and Whitworth thread and decimal equivalents of nominal sizes of drills are also included.

The Bickford Drill & Tool Co., Cincinnati, Ohio. Radial Drill catalogue for 1906. Halftone illustrations show the complete line of radial drills and descriptions of the various parts and general specifications for the different styles complete the data.

Newton Machine Tool Works, Inc., Philadelphia, Pa. Catalogue No. 44—Keyseat Milling Machines, illustrates and describes the two sizes of this machine, and enlarged illustrations make clear the method of operation. A special machine for locomotive axles is shown and a new design of machine used for heavier and longer shafts is also illustrated.

Quincy, Manchester Sargent Co., 114 Liberty Street, New York City, have issued a new catalogue with adjustable leather cover fastened by screws, by means of which new leaves may be inserted as they are issued. The book contains illustrations and brief descriptions of the standard tools of the company, attention being called to the more important points only.

The P. L. Abbey Co., Kalamazoo, Mich. Circular describing emergency accident cabinets for individuals, shops or stores and manufacturing plants. The $7.00 size, designed for the manufacturing plant, comprises an emergency outfit, for accidents, that no shop should be without, as its presence may often save loss of life or serious consequences due to an accident not being properly attended to in time.

National Association of Manufacturers, 170 Broadway. Proceedings of the 11th annual convention, 1906, held at New York, May 14-16. The proceedings are given in full, including addresses of welcome, committee reports, etc. The proceedings are well worth study by those interested in discussions of the labor problem, strikes, metric system, railroad rate legislation and general commercial problems affecting manufacturers and their products.

Association of Licensed Automobile Manufacturers, New York. Bulletin No. 18, containing standard for hexagon head screws, castle and plain nuts adopted by the Association of Licensed Automobile Manufacturers. It has been found that the Sellers, or U. S. Standard screws, do not meet the requirements of automobile construction satisfactorily, the pitches being too coarse. Tables showing the dimensions, pitches, etc., will be given in a later issue.

J. H. Wagenhorst & Co., Youngstown, Ohio. Leaflet giving in concise form a description of the electric blueprinting machine manufactured by them; also testimonials from satisfied customers. The leaflet includes prices for various sizes of the machine. An important feature is the roller curtain which makes the placing of a tracing and sensitized paper an easily-accomplished operation. It also permits the printing to be examined at any time without the danger of disarranging the relative position of the tracing and paper.

The Gisholt Machine Co., Madison, Wis. Leaflet descriptive of the Gisholt turret lathe equipment for railroad shops showing tools designed for finishing crossheads, eccentrics, pistons and bull-rings. This equipment is of particular interest because it was thought, not long ago, that turret lathes could not be used economically on such parts on account of the comparatively small number made at one time. This equipment, however, is of such simplicity of construction that it is quickly set up and used economically on a few pieces as well as on a large number.

The Board of Trade, of Columbus, Ohio, has issued an attractively illustrated pamphlet on Columbus, showing the principal buildings, streets, manufacturing industries, etc. It tells of the advantages of Columbus for manufacturing industries and as a place of residence. Situated in central Ohio, a radius of 500 miles reaches all the principal parts of Eastern United States, thus indicating that the city is located in a strategic position as regards the distribution of products throughout this part of the country. A map graphically illustrates this fact.

Joseph Dixon Crucible Co., Jersey City, N. J. General catalogue giving description and illustrations of the principal graphite productions of the company. Prices are not included but are given in the form of a special price list, which will be sent free upon request. "Graphite Lubricants" is a booklet setting forth the important facts together with the prices of Dixon's lubricating graphites and graphite lubricants. A little pamphlet on Dixon's Graphite Brushes describes the use of same and gives the results of tests made upon these brushes by Prof. Albert F. Ganz of Stevens Institute.

Drexel Institute, Philadelphia, Pa. Circular offering the following classes in engineering subjects during the coming season: 1, Engineering Drawing; 2, Mechanics and Heat; 3, Elements of Chemistry; 4, Engineering Electricity; 5, Advanced Engineering Electricity; 6, Strength of Materials and Machine Design; 7, Advanced Strength of Materials and Machine Design; 8, Thermodynamics and Steam Engineering; 9, Plane Surveying; 10, Advanced Surveying. Although stated separately, the foregoing subjects may be grouped in courses in electrical, mechanical or civil engineering, the exact combinations being dependent upon individual needs.

Geo. V. Cresson Co., Philadelphia, Pa. Catalogue of cast iron pulleys. The three standard types of pulleys—whole, parting, and clamp-hub—and special pulleys made for use on electrical machines are described and illustrated. In the back of the catalogue is given a report of the tests made by R. C. Carpenter, of Cornell University, to determine the efficiency of the para-pneumatic pulley as compared with the smooth-faced pulley. The results show a decided superiority of the para-pneumatic pulley over the common, plain pulley in transmitting power for the same width of belt and under the same conditions of loading. The tables accompanying the tests give full details of data and results.

Chas. H. Besley & Co., Chicago, Ill. Catalogue of Besley spiral disk grinders, Besley band grinders and polishing machines, Helmet spiral circles, etc. Attention is called to four new machines, these being No. 11, for patternmaking and light metal grinding; No. 12, for heavy metal grinding; No. 14, with lever feed; and No. 6, model 1906, double disk grinder. A feature of the catalogue is the tables of Helmet spiral paper circles numbered for various materials, such as cast iron, brass, soft steel, hard steel, malleable iron, general grinding, hard rubber, wood, etc. About 12 numbers of abrasive are available for each of the various classes of substances. The numbers mostly used are identified by bold-faced type. Books containing sample sections of the various grades of abrasive disks used are supplied to dealers for the convenience of customers in selection.

The Western Tube Co., Kewanee, Ill. Pamphlet describing "high duty" metal, a new bronze mixture which shows a loss of tensile strength when subjected to a temperature of 407 degrees F. of only 5.6 per cent. This metal has been developed after an extensive series of tests of known bronze mixtures. The best of these, the United States Government mixture, consisting of 88 parts copper, 10 tin, and 2 of zinc, was found to be as little affected by high temperature as any developed heretofore. The decrease in strength at 407 degrees F. was a drop of 9 per cent from the cold tensile strength of 33,633 pounds per square inch. "High duty" metal, however, shows a strength of 31,627 pounds per square inch at 407 degrees F. as against 30,675 pounds for United States Government metal. Its wearing qualities are good and the alloy is tough, thus resisting shock due to water-hammer, etc.

MANUFACTURERS' NOTES.

Eberhardt Bros. Machine Co., Newark, N. J., are building an addition to their assembling room which will enable them to handle about double the present output.

Burke Machinery Co., of Cleveland, Ohio, manufacturers of oil furnaces and bench machinery, have recently moved to their new factory, corner Perkins Avenue and 35th Street.

The Morse Chain Co., formerly of Trumansburg, N. Y., have moved their general offices and shops to Ithaca, N. Y., where a new plant of the best modern construction has been erected.

The Armstrong Bros. Tool Co., Chicago, Ill., have installed additional machinery so as to keep up with their orders and get some finished stock ahead. The sales of Armstrong cutting-off and grinding machines are increasing steadily.

Chas. H. Besley & Co., 15 South Clinton Street, Chicago, Ill., will exhibit their Besley Spiral Grooved Steel Disc Grinder and their Helmet Spiral Paper and Cloth Circles at the Olympia, London, England, Exposition to be held from September 15 to October 17, 1906.

The Cleveland Twist Drill Co., Cleveland, Ohio, have recently completed an addition to their factory that will enable them to increase their capacity 25 per cent. They have also built a new power plant containing a 1,250 H. P. engine and 1,600 H. P. in new boilers.

The Jacobs Mfg. Co., of Hartford, Conn., makers of the Jacob improved drill chucks, have been forced to move into a larger and more convenient factory. They are installing additional machinery and hope in the near future to be able to take care of their rapidly-increasing business.

J. H. Wagenhorst & Co., Youngstown, Ohio, report the following recent sales of electric blue printers: Eugene Dietzgen Co., New York; Wisconsin Telephone Co., Milwaukee, Wis.; Calumet & Hecla Mining Co.; Carnegie Steel Co.; Swift & Co., Chicago, Ill.; the A. O. Smith Co., Milwaukee, Wis.

The Lyon Metallic Mfg. Co., formerly of Chicago, Ill., are now located at Aurora, Ill., where they have erected a large factory, giving them a capacity of over four times the old plant. They will manufacture on a large scale lockers, steel tool boxes, tote pans, oil cans, steel shelving, portable tool racks and all kinds of metal machine shop furnishings.

Armstrong Bros. Tool Co., "The Tool Holder People" of Chicago, have just shipped two orders received recently from the Isthmian Canal Commission, aggregating almost one thousand Armstrong tool-holders, many heavy sizes being included. They have also received recently an order for universal ratchets for use in the Canal Zone. Many smaller shipments have preceded these later orders.

The New Era Mfg. Co., Kalamazoo, Mich., manufacturers of metallic phosphoro (phosphor tin improved), white bronze, babbitt metals and special alloys, are now occupying their new quarters at the corner of Cobb Avenue and the S. H. Branch of the Michigan Central Railroad, and are thoroughly equipped and prepared to take care of any quantity of business in their line.

John MacGregor formerly superintendent of the Pope Manufacturing Co., Hartford, Conn., is now manager of MacGregor's Engineering and Employment Agency, Springfield, Mass. This is a newly organized concern developed on the basis of an old agency which was bought out. It is the intention to conduct a first-class agency for employment by men who have been "through the mill" and know something of the actual requirements of employers and who are personally able to judge of the abilities of employees.

The Goldschmidt Thermit Co., 43-49 Exchange Place, New York, are about to vacate their present manufacturing premises at 179 Christopher St., New York, as they are insufficient for their largely increasing business. They have bought ground at the corner of Cornelison and Bishop Sts., Jersey City, N. J., and have there erected a large factory building 75 x 165 feet. This location is within easy reach of their down-town offices. They intend removing the manufacturing plant from its present location to the new plant on or about October 1st.

The Carborundum Co., Niagara Falls, N. Y., have started building a large branch plant in Germany. They are the sole American manufacturers of carborundum in the various forms used for grinding purposes and the demands of their European trade make the establishment of branch works of carborundum on the continent an absolute necessity. The German company has been formed under the title of "Deutsche Carborundum Werke, G. m. b. h.," and is located at Reisholz, a manufacturing suburb of Dusseldorf-on-the-Rhine. The new works, which will embody all the latest and improved machinery for the manufacture of abrasive materials, is expected to be in operation about January 1, 1907.

The International Correspondence Schools, Scranton, Pa., will celebrate the fifteenth anniversary of the schools at Scranton, Pa., October 16. The schools were started by Mr. Thomas J. Foster, then editor of a newspaper in Shenandoah, Pa. He introduced a method of teaching through the mails by means of special home study text books and a system of direction and correction of student's work, the object of which was to enable the coal miners of Pennsylvania to pass the required examination for mine foremen. It was little dreamed that this was the beginning of a new educational system which would eventually turn the whole world into a vast school room and offer the means by which men in almost every trade or occupation could improve their education and consequently their money-earning power. The school now has 200 courses of instruction, covering almost every branch of the well-known trades and professions. Up to the present time 85,000 students have either completed the course for which they enrolled or a substantial portion thereof; 225,000 other students have completed the study of mathematical, physical and drawing subjects. These figures seem the more impressive when it is known that the largest number of students graduated by any one American school is 28,000, this being the record of Harvard University, an institution more than 200 years old.

RAILWAY MACHINERY.

A special edition of MACHINERY devoted to Locomotive and Car Equipment and Mechanics.

November, 1906.

THE LEHIGH VALLEY RAILROAD SHOPS, SAYRE, PA.

The principal repair shops of the Lehigh Valley Railroad are at Sayre, Pa. As at present constituted, the locomotive and car repair shops cover nearly 55 acres, and the layout is shown in Fig. 5. The buildings belonging to that part of the plant known as "the new shop," built in 1904, are the power house, main locomotive shop, blacksmith stores, scrap dock and various other small buildings in the immediate vicinity.

Beneath the gallery are located the various gangs for doing special work, including those working on the air brakes, spring rigging, brake rigging, rod and motion work, steam pipes, and painters, tinsmiths, and pipe fitters. The toolroom is located under the gallery.

The various shops and bays are served by thirteen electric traveling cranes located as follows: One 120-ton crane in the east erecting bay; one 120-ton crane in the west erecting bay; one 15-ton crane in the east erecting bay; one 15-ton crane in the west erecting bay; two 15-ton cranes in the east covered yard; two 15-ton cranes in the west covered yard; two 15-ton cranes in the east machine shop; two 12-ton cranes in the west machine shop; and one 30-ton crane in the boiler shop for the gap riveter.

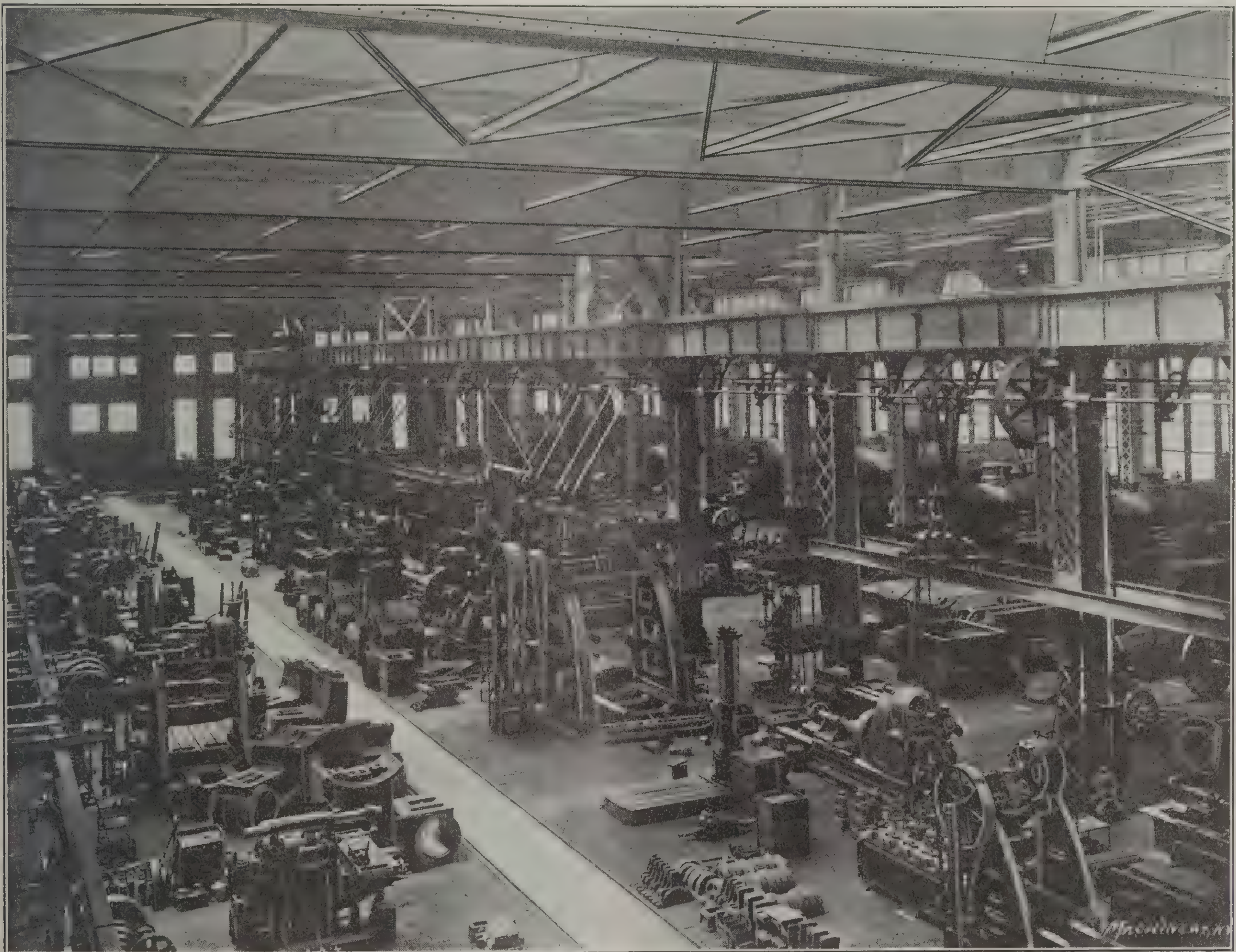


Fig. 1. View from Gallery of the East Machine Shop, showing North End of Bay.

The boiler shop and locomotive shop with which this brief description has principally to deal are under the same roof and are of large size, being 360 feet wide and 750 feet long. The boiler shop occupies a space 120 x 360 feet at the south end of the building, a view of one part of which is shown in Fig. 11. The main locomotive shop has a floor space 360 x 630 feet and a gallery of 36 x 630 feet, where are located the heaters, lavatories, toilets, locker rooms, belt room, etc. The locomotive shop is divided into two main departments, known as the east and west shops, respectively. Both are of the transverse track type and have accommodations for forty-eight engines, which number may be increased to fifty-two by utilizing, when necessary, the two main cross tracks. The shop is in all essentials a double shop, there being on each side an erecting shop, covered yard, and machine shop, with a gallery in the center.

Figs. 1 and 2 show general views in the east machine shop and are taken from the gallery near the middle of the shop. The row of locomotive pits on the side are shown in the background in each case. The views shown in Figs. 3 and 4 give an idea of the length of the shop; Fig. 3 is taken on the ground level in the west machine shop, showing nearly the full length.

The floors are built of 2-inch hemlock plank laid diagonally on 5 x 8-inch timbers, which latter are imbedded in concrete in a natural gravel bed. Over the plank is laid 7-inch maple

flooring 3 inches wide. The floors are laid first and then the outline of the various machine foundations are in most cases cut out by a portable saw with an electric motor. This machine is illustrated in Fig. 13 and is one of the greatest laborsavers for the purpose devised that can well be imagined. It consists essentially of an electric motor mounted on a frame which is pivoted on top of a four-wheel truck. The chines may seem at first thought like a rather wasteful process, it was the most practical method to follow in this case, and perhaps was the most economical from all points of view. The laying of the flooring was, of course, greatly simplified by having no machine foundations to work upon, and with the portable machine the cutting out to the exact shape required was a very simple and expeditious process. The saw

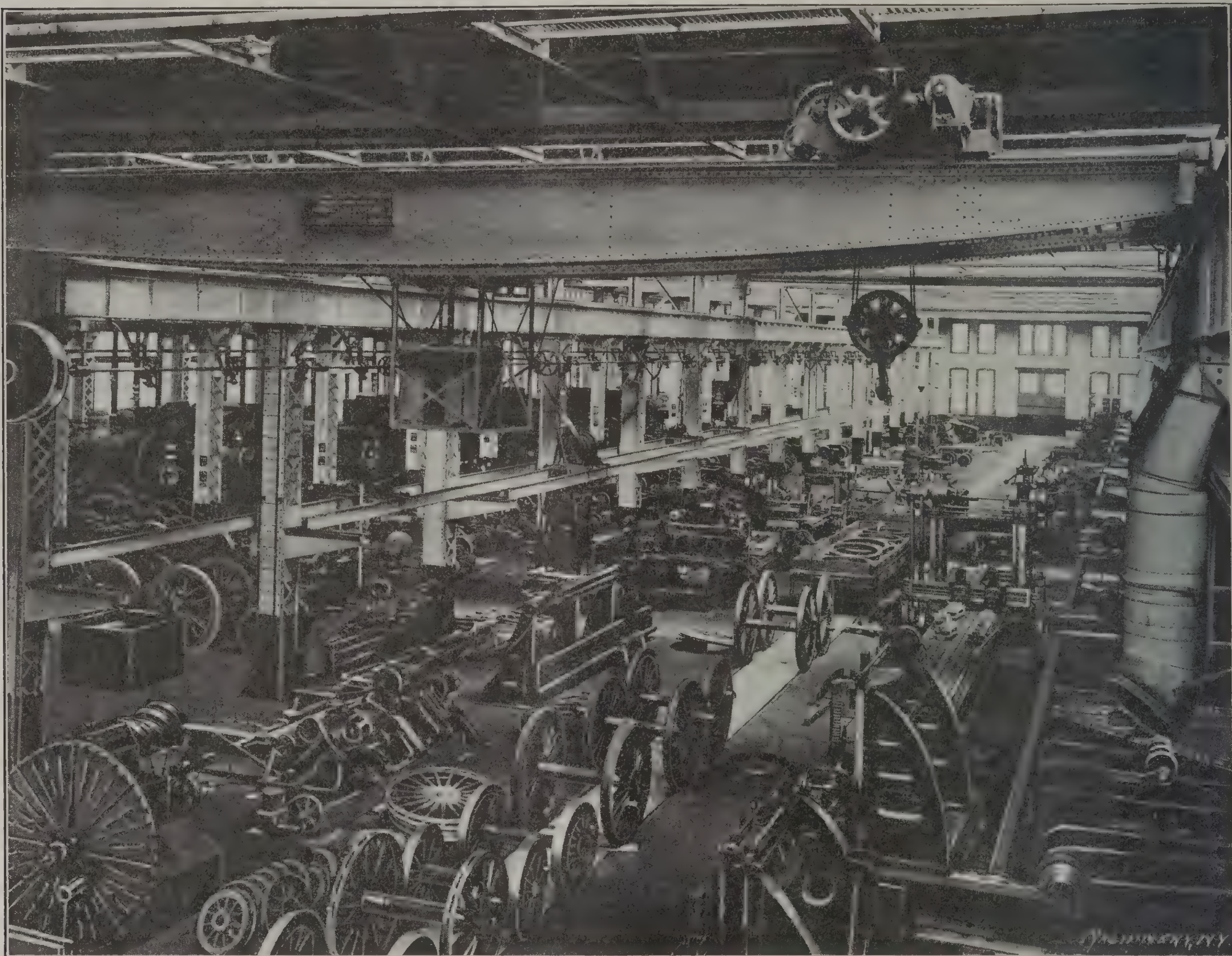


Fig. 2. View from Gallery of East Machine Shop, showing South End of Bay.

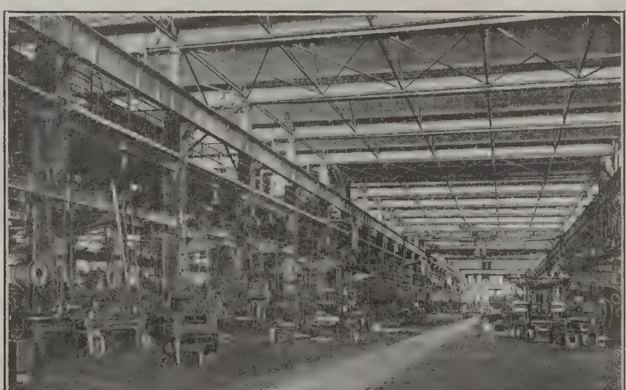


Fig. 3. View of nearly the Entire Length of the West Machine Shop Bay, looking South.

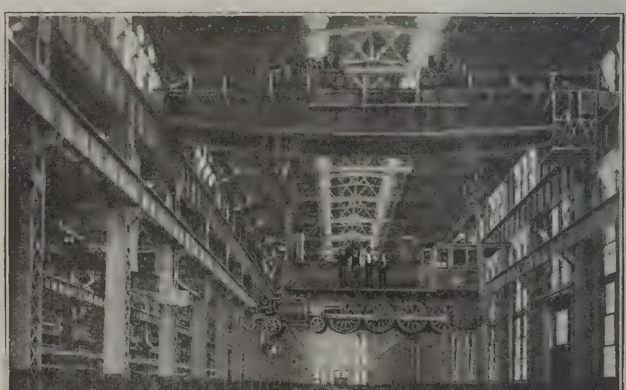


Fig. 4. View from South End of East Erecting Shop Bay.

motor is belted to a saw and a hand-wheel is provided by which the frame carrying the motor and saw can be tilted so as to cut into the flooring. The wheels are guided into temporary trucks while sawing and the feed motion is by hand.

While the plan of laying the floor over this immense area without breaks and then cutting out the places for the ma- cuts through wood, nails and concrete with cheerful indiscrimination and did in a comparatively few hours what would have been a tremendous job if performed by hand labor. It was really necessary to lay the flooring first, as in many cases the floor plans of the machines could not be obtained at the time the floor had to be laid.

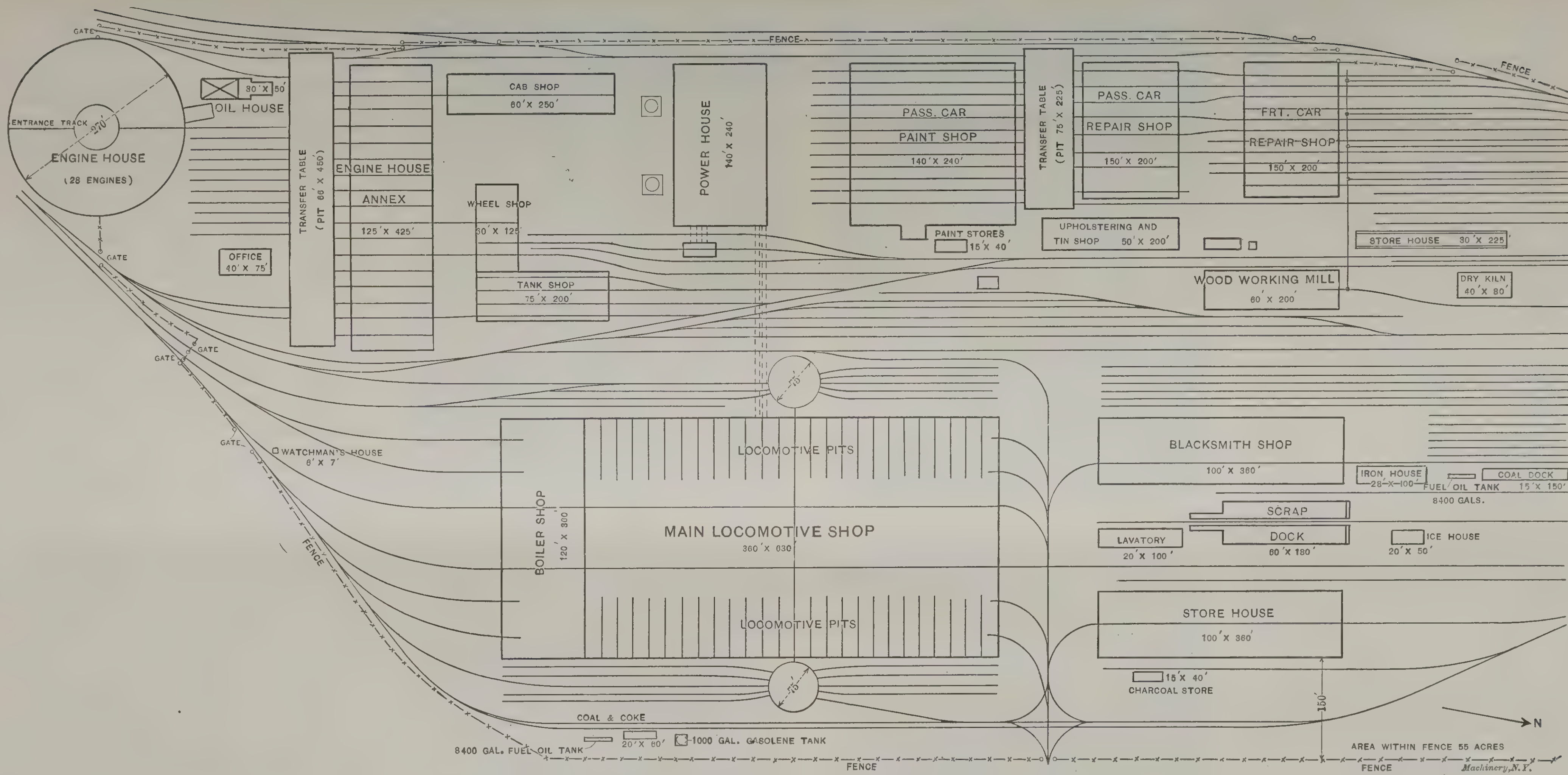


Fig. 5. Locomotive and Car Repair Shop Yards, Lehigh Valley Railroad, Sayre, Pa.

JOY VALVE GEAR NOT EXPERIMENTED WITH BY THE PENNSYLVANIA RAILROAD.

An erroneous statement was made in the October issue in the report of the discussion on the paper "Walschaerts vs. Stephenson Valve Gear," read at the New York Railroad Club in September. We inferred from the discussion that some years ago the Pennsylvania R. R. had experimented with a locomotive equipped with the Joy valve gear, but such is not the case; Mr. A. W. Gibbs' (General Superintendent of Motive Power, Pennsylvania R. R.) experience with the Joy gear was obtained on a Southern railway and not on the Pennsylvania R. R.

* * *

RYERSON FLUE CLEANING MACHINE.

An interesting flue cleaning machine for locomotive shops, which is quite a radical departure in principle from the usual type of cleaner, is made by Jos. T. Ryerson & Sons, Chicago. The flues are loaded on a car having a short cradle and are run under a gallows frame which stands over a concrete pit partially filled with water. Two wide faced endless chains mounted on sprocket wheels on the gallows frame are slipped over the ends of the flues and the car is then backed off the pit. The machinery is so adjusted that the chain loops are then lengthened sufficiently to immerse the flues in the water where they are turned over and over by the chain loops, running on the sprockets which are driven by an electric motor. The new process is advantageous not only in saving labor in handling flues but is nearly noiseless, the flues being entirely immersed in water during the operation. Five hundred flues may be handled at one time, the cost, it is claimed, being less than four cents per hundred flues. A model showing the complete operation was exhibited at the Master Mechanics' Convention at Atlantic City last June.

THE DESIGNING OF A LOCOMOTIVE.—18.

THE TRUCKS.

GEO. L. FOWLER and CARL J. MELLIN.

The truck is an essentially American characteristic of the locomotive. For many years European locomotives, especially those used in freight service, were built without any truck, and the guiding of the engine was done by the flanges of the front pair of wheels. In this country, however, the truck has always been used upon road engines and has been considered an essential detail in their safe and satisfactory operation.

Broadly speaking, the engine truck proper, or the one located at the front end, may be divided into two classes, the two- and four-wheeled types. The four-wheeled truck is the one that has been universally used on locomotives intended for passenger service, while the two-wheeled has been applied to freight engines, or those that are used, for the most part, in freight service, with an occasional assignment to passenger work. The exclusion of the two-wheeled truck from engines designed for passenger service has been due to the necessity of using a large boiler and so increasing the total weight of the engine beyond the requirements of adhesion represented by the tractive power that it was desired to develop. Under these circumstances the extra weight, beyond that needed for adhesion, could be carried on four wheels to better advantage than on two. As for safety, there is no difference of opinion that the two-wheeled truck is quite up to all the demands of the most exacting service.

In the designing of the trucks there is little else to be done than to secure ample strength to carry the load imposed and arrange for axles and boxes of sufficient bearing surface to do the work required without heating. At the same time care must be taken that sufficient weight is put upon the truck to hold it down, and cause it to keep the rails upon the sharpest curves to be encountered, and thus prevent the flanges of the wheels from climbing the rail and causing a derailment when called upon to guide the direction of motion of the machine from a straight line to a curve and through the latter.

In the case of the consolidation engine under consideration, as well as upon those of the mogul class, the two-wheeled pony or Bissel truck is used.

The plan of framing this type of truck is shown in Fig. 86 and the details of the working parts in Fig. 87. From these drawings, as well as from a comparison with Fig. 82, it will be seen that the truck is pivoted at the center between the wheels. As this would not hold them in place on the rails, but would allow them to swing into a position approximately longitudinal to the track, if any obstruction were to check the motion of one, a radius bar, A, is added that reaches to a point beneath the engine, where it is pivoted on the center point. This point is carried back far enough to insure stability of the wheels upon the rails, and, at the same time, permit of sufficient side motion to allow the truck to swing out of line with the center of the engine when entering and passing over a curve.

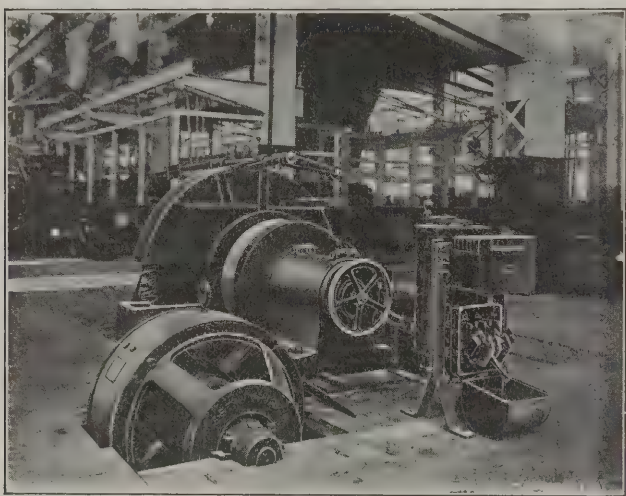


Fig 6. Forty-five-inch Car-wheel Lathe.

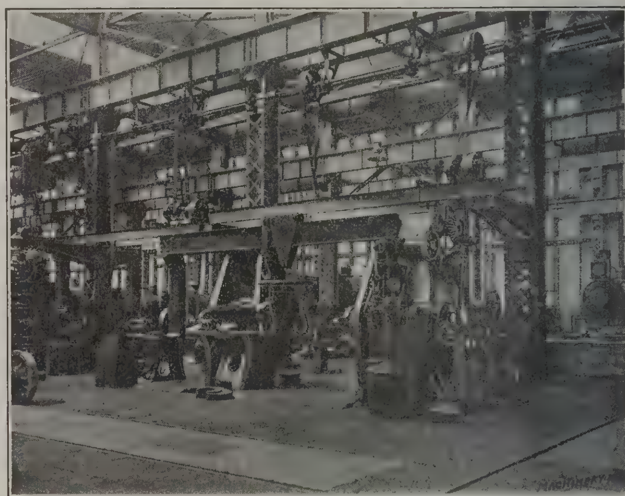


Fig. 7. Five-hundred-ton Wheel Press.

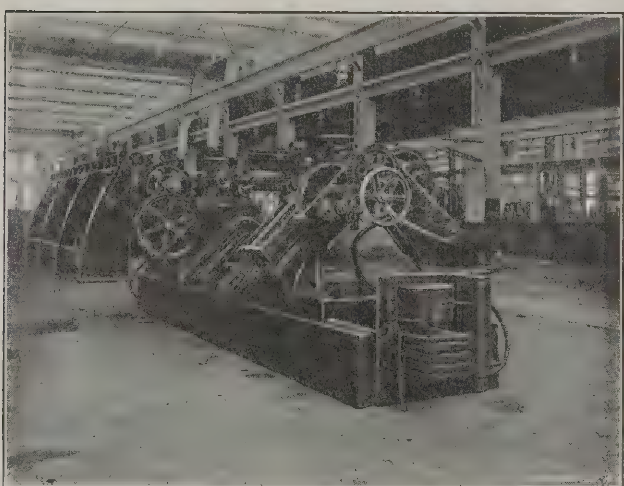


Fig. 8. Ninety-inch Quartering Machine.

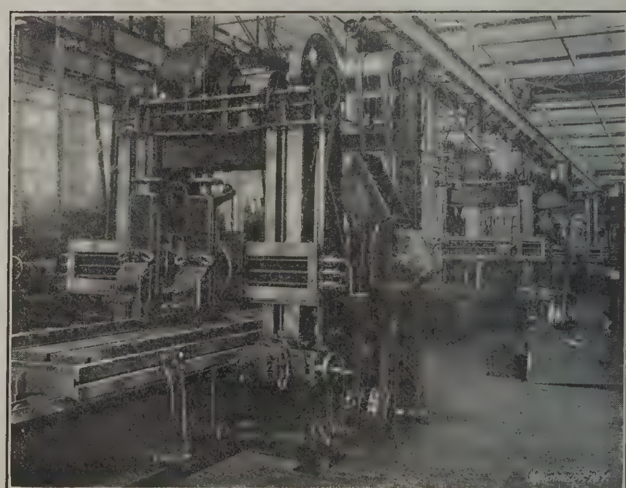


Fig. 9. Motor-driven 36-inch Planer in Foreground.

The formula used for calculating the length of the radius bar is as follows:

$$R = \frac{A \times B}{A + B} \times 0.85 \qquad (75)$$

in which

R = the length of the radius bar;

A = the total wheel-base for consolidation and mogul locomotives;

B = the distance from the front driving wheel to the truck wheel.

In the case of the consolidation locomotive under consideration, $A = 314$ inches and $B = 124$ inches. The formula (75) therefore becomes:

$$R = \frac{38,936}{438} \times 0.85 = 75.56 \text{ inches.}$$

This, then, may be taken as the distance from the pivotal point of the radius bar to the center of the truck axle, which in this case is made 6 feet 3½ inches for constructional reasons.

As the radius bar has no load to sustain and the only stress to which it is subjected is that of holding the wheels on the track, it is usually made of a flat bar of steel about 5 inches by 1¼ inch laid flat and stiffened by round braces rising diagonally from the foot of the pedestals and bolted to the horizontal portion of the bar itself at a convenient distance back of the truck frame.

In the case of the truck under consideration, the frame is carried by two helical springs at each side, and these, in turn, rest on seats attached to yokes that set on top of the axle boxes.

We have already noted that the weight on the truck of this engine is to be about 21,000 pounds, or 10,500 pounds on each wheel. In order to carry this load an axle 6 inches in diameter is provided with a journal 9⅞ inches long. This gives a load of about 177 pounds per square inch of projected area, or somewhat less than the 180 pounds that was allowed for the driving axles of freight locomotives.

The ordinary four-wheeled front truck of locomotives used on the eight-wheeled, ten-wheeled and Atlantic types calls for little or no calculation that is of value other than the determination of the strength of the equalizing bars from which the semi-elliptic springs, upon which the frame rests, are suspended. The front end of the engine rests, through a center

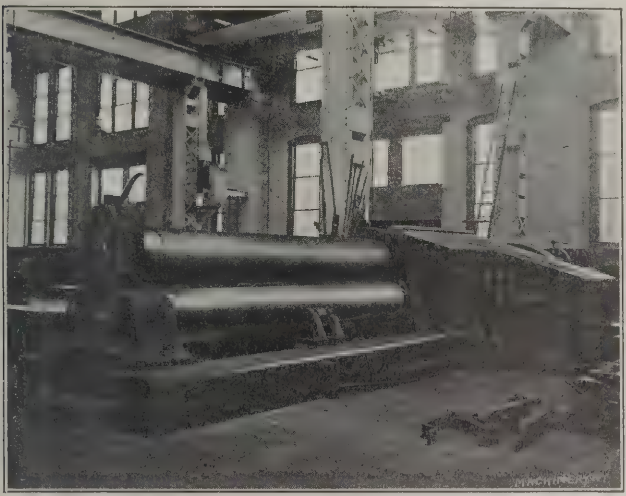


Fig. 10. Large Bending Rolls.

Fig. 11. Flange Fire Layout in the Boiler Shop.

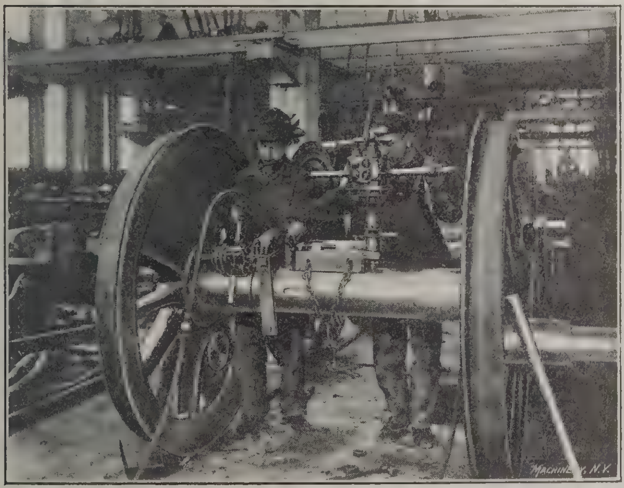


Fig. 12. Use of Air Tools Drilling Holes for Hub Liner Studs and Milling Keyways for Eccentrics.

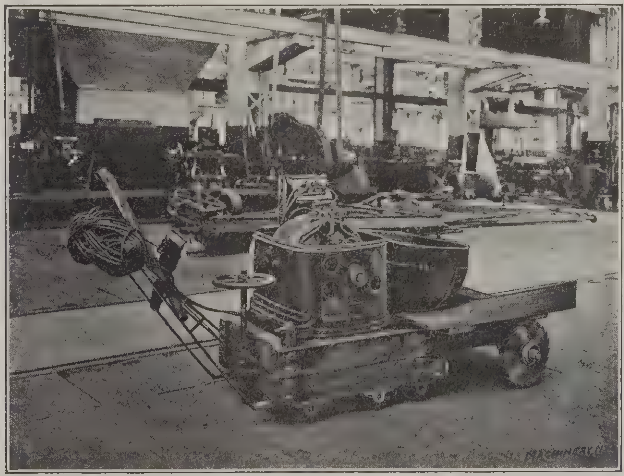


Fig. 13. Portable Routing Saw for Cutting Out Floors for Machine Foundations.

The design of frame, as shown in Fig. 87, may be taken as typical of that in use upon mogul and consolidation locomotives in the United States, and is of an exceedingly simple construction.

The weight of the front end of the engine is carried on the center plate, and this in turn is suspended by the center plate hangers from the transoms that reach across from side to side. These hangers are spread a small amount at the bottom so as to increase the tendency of the truck to return to the central position when coming back to a straight line from a curve. As the center plate and the pivot pin of the radius bar are normally located in the center line of the truck, it would be merely an extension of the rigid wheel base if no lateral flexibility were given to the wheels. It is this lateral flexibility, and the pull on the center plate by the hangers that tends to guide the front of the engine out of a straight line and around a curve.

plate on the saddle, upon the center plate of the truck. In the particular track, illustrated in Fig. 88, the center plate is suspended from the transoms by hangers in the same manner as in the case of the pony truck for the consolidation locomotive. There is a difference in the form of the hangers, however, in that, in this case, the hangers have two bearings at the top, arranged so that the two on either side act as inclined hangers, and yet remain parallel to each other and this tends to keep the center plate in a horizontal position.

In the calculations of the weight to be given to this Atlantic type locomotive, the total is 168,000 pounds, of which 80,000 pounds are upon the driving wheels. Of the balance, about 48,000 pounds will be upon the front truck and 40,000 pounds upon the rear. This puts a load of 12,000 pounds on each of the four forward wheels, with which a 5¾-inch axle is used having journals 12 inches long. This gives a pressure of somewhat less than 170 pounds per square inch of projected area,

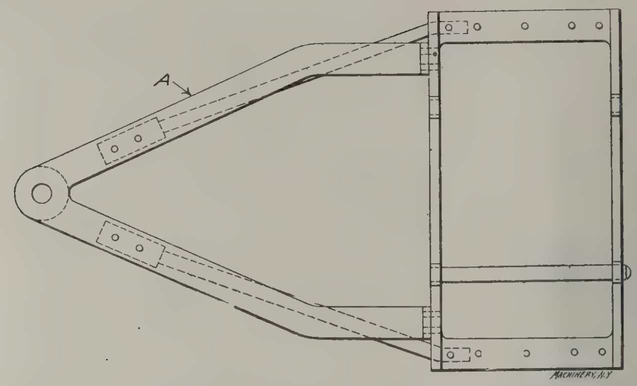
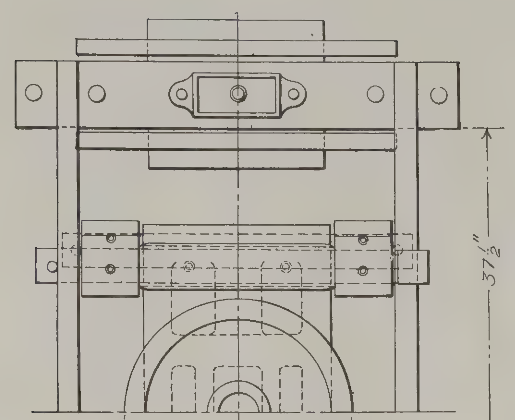


Fig. 86. Outline Plan of Pony Truck Frame for Consolidation Locomotive.



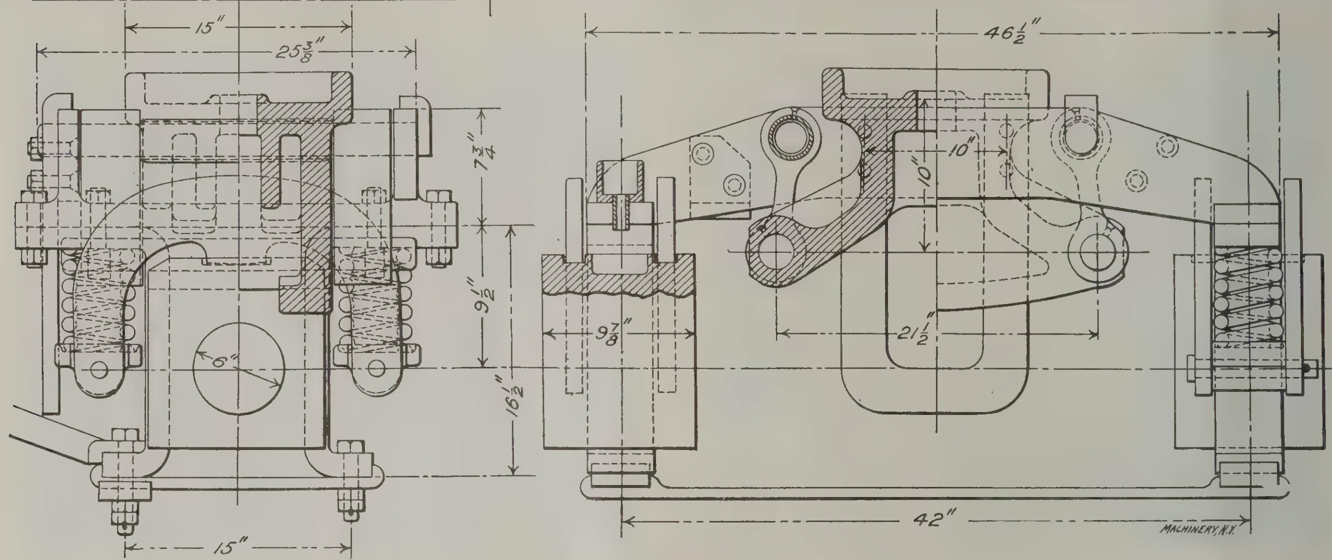


Fig. 87. Pony Truck Frame for Consolidation Locomotive.

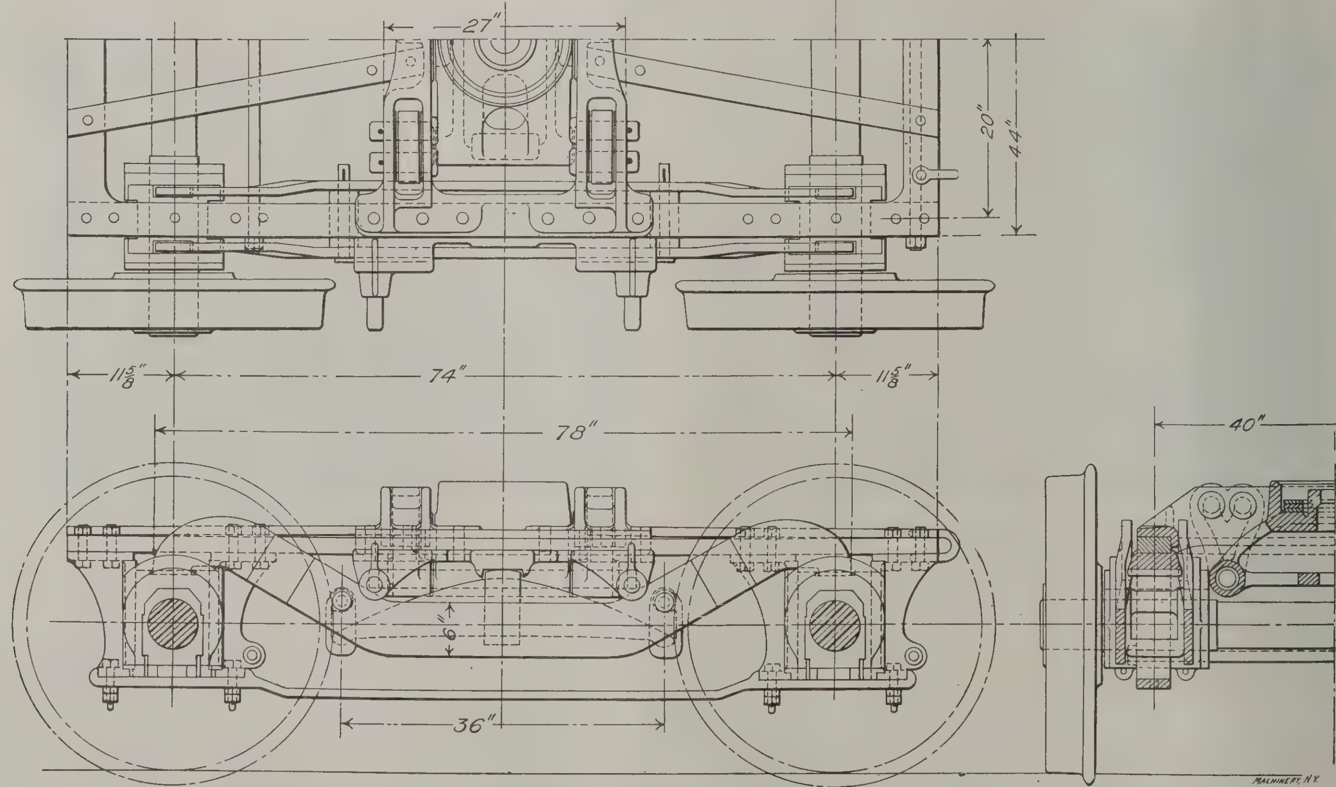


Fig. 88. Four-wheeled Forward Truck for Atlantic Locomotive

when allowance is made for the weight of the wheels, or about the amount allowable on the driving journals of a passenger locomotive. The wheel base of these four-wheeled trucks averages from 6 feet to 6 feet 6 inches. This is a matter that is subject to change due to local conditions, such as the diameter and arrangement of the cylinders, the position of the forward pair of drivers, the proportion of weight that is to be carried on the truck, and other items for which no rule can be laid down, and for which the designer must depend upon his own experience and knowledge of the fitness of things.

The rear truck of the Atlantic locomotive is of special design and varies with the builder. This type of locomotive has led to several designs of trucks for this point, most of which have been patented by the locomotive builders or individuals connected with the railroad service.

It is essential that the wheels should have a lateral flexi-

bility of movement, as in the case of the pony truck of a consolidation locomotive, in order that the virtual length of the rigid wheel base may be kept down to the actual length, or the distance between the driving wheel centers. It is also desirable that the center line of the axle shall remain as near radial to the curve of the truck as possible.

The trucks used in this place are designed with such an end in view.

As in the case of the other trucks, no formulas can be given for the determination of the dimensions of the several parts, other than the ordinary ones in use for beams and similar structures.

In the truck, illustrated in Fig. 89, the axle is 8 inches in diameter with a journal 14 inches long. As this has to carry a load of approximately 20,000 pounds at each end the load per square inch of projected area is less than the 170 pounds allowable on passenger driving axles when due allowance is made for the weight of the wheels.

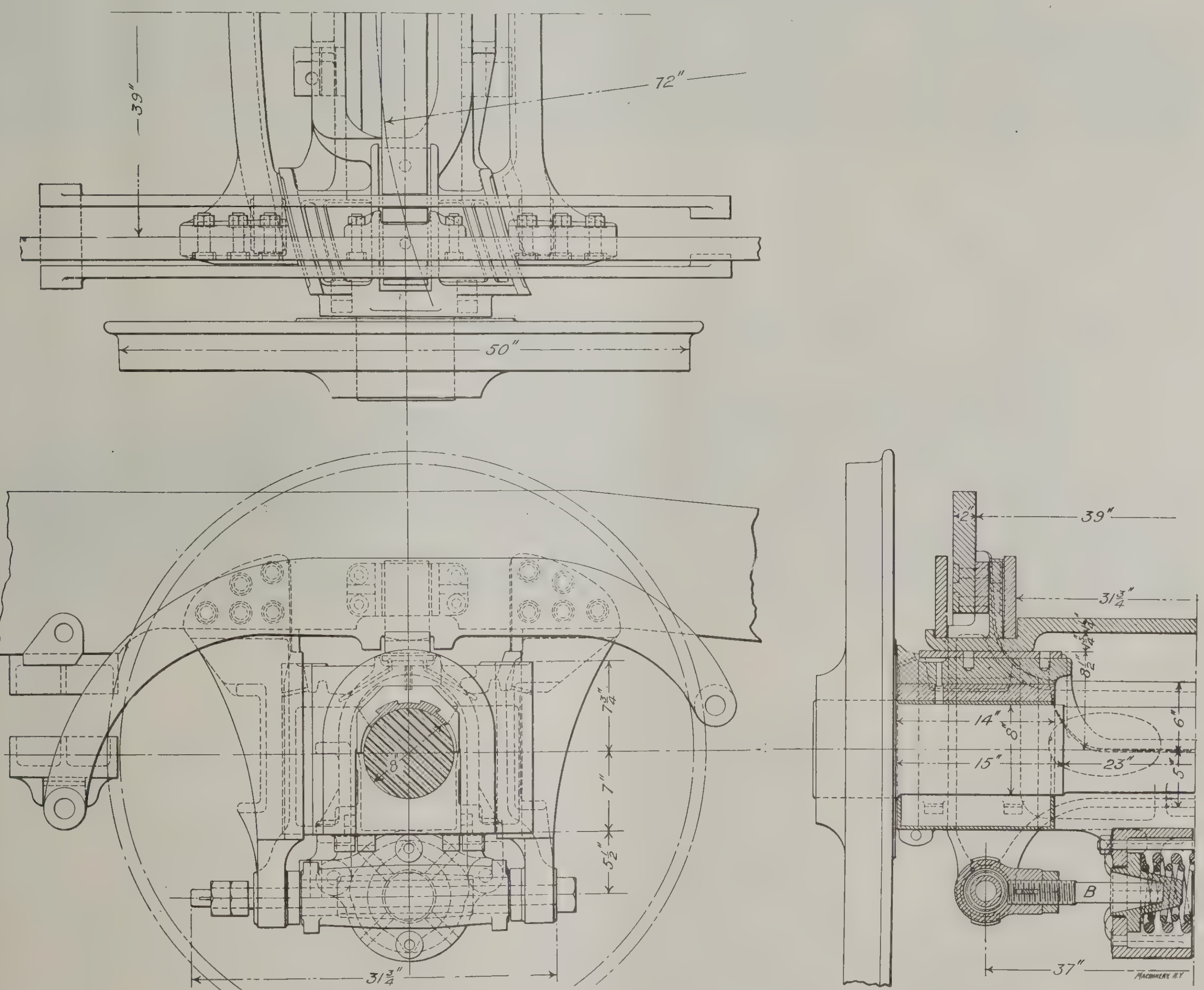


Fig. 89. Radial Trailing Truck for Atlantic Locomotive.

The axle is, of course, straight; but the boxes, instead of having their wearing surfaces parallel to its center line, are set in pedestal jaws that are cut at an angle and on a radius of 6 feet.

Hence, the transverse movement of the wheels is the same as though they were swinging through the arc of a circle whose center is at the center of curvature of the faces of the pedestals. This holds the wheels at an approximation to a truly radial position, but not exactly.

The swing of the overhang of the engine beyond the rigid wheel base throws these wheels out of center and the return of the frame to its central position on a straight track would restore the normal condition of things, but assistance is rendered in overcoming the resistance of the boxes to this movement by a centering spring placed beneath the axle. The pedestals are, of course, rigid transversely with the main frame of the engine and carry the push bars *B*, that bear against followers that are set in castings that move laterally with the boxes. Any movement of the latter, in either direction, compresses the intermediate spring, which thus has a constant tendency to restore the truck to its central position.

It will thus be seen that very little of a guiding nature can be said regarding the designing of the trucks that are to be used under American locomotives. The general design of the pony and the four-wheeled truck has been established by such long usage that it is no longer a subject for discussion. Details are being constantly varied to meet the changing demands of weight, proportions and service, but with no essential change in the main features of the designs.

With the rear truck of the Atlantic, Pacific and Prairie types of locomotives, the case is somewhat different. These locomotives have not been in service long enough to have settled down to an established basis of construction in detail and it will probably be a number of years before this will be done. Meanwhile the general principle of the freedom of lateral movement for the wheels, with the approximation to the maintenance of a radial position for the axle has been accepted and acted upon, and beyond this the truck may be said to be in a process of development, though the engines to which it is applicable may be considered as among the standards of American railroad practice.

* * *

The New York *Times* says that Edison has at last perfected his famous storage battery; also that it wearies the imagination to speculate on what this means for the world. It also wearies the world to think how many times it has been "perfected." It is to be hoped that this "perfection" means that the public will soon be able to realize its advantages.

ISTHMIAN CANAL COMMISSION LOCOMOTIVES.

The accompanying half-tones show two mogul locomotives of which 120 have been ordered by the Isthmian Canal Commission for the Panama Canal construction. The locomotive shown in Fig. 1, road No. 205, has 19 x 24-inch cylinders, 48-inch drivers, and a total weight of 130,500 pounds. The tractive power is 27,650 pounds; the weight on drivers is 114,000 pounds. Of this type 100 were ordered.

Fig. 1. Isthmian Canal Commission Locomotive No. 205.

Fig. 2. Isthmian Canal Commission Locomotive No. 603.

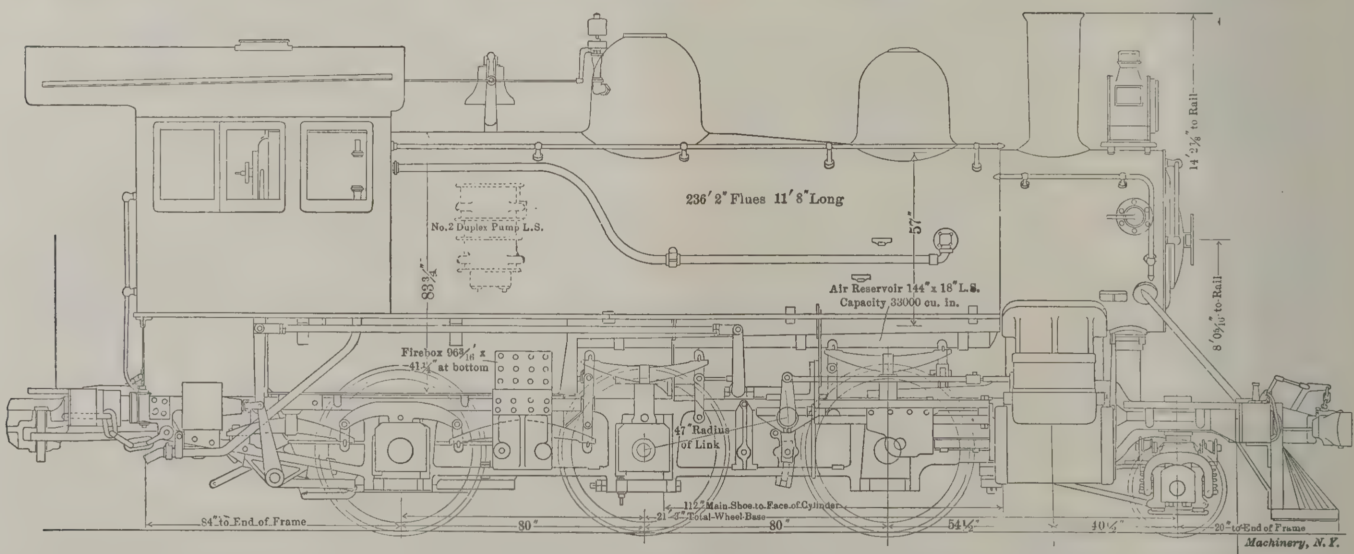


Fig. 3. Isthmian Canal Commission Lococomotive. General Dimensions, 19x24-inch Cylinder Class.

Fig. 2 shows a somewhat heavier design, road No. 603, the total weight being 147,500 pounds. The cylinder dimensions are 20 x 26 inches, the drivers 63 inches, and the tractive power is 25,250 pounds; the total weight on the drivers is 127,500. The total heating surface is 2,203 square feet, of which 174 square feet is in the firebox and the remainder 2,029 square feet, in the tubes. The boiler pressure is 180 pounds per square inch for both types. The gage is 5 feet.

These locomotives are of the ordinary mogul or 2-6-0 type and about the only peculiar feature of design worthy of note is unusually long and low tenders. The tenders are so designed to avoid any danger of their "turning turtle" because of the uneven and rough road bed over which they will ordinarily have to run.

* * *

The New York Central R. R. and its traffic manager, Mr. Frederick L. Pomeroy, have been found guilty of rebating on their freight rates in favor of the sugar trust, and October 19 Judge Holt fined the company $108,000 and Mr. Pomeroy $6,000 for the offense.

SPECIAL TOOLS FOR DRILLING HOLES IN TIME AND PERCUSSION FUSES AND FIRING RINGS.

W. R. BOWERS.

The accompanying cuts show some special jigs for drilling holes in fuse components. In this class of work there are two important features, firstly, the holes have to be very accurate both as to size and position and, secondly, interchangeable work has to be turned out at the lowest possible cost. It is essential that the degree of accuracy should be very high, as the whole result of the firing of both large and small guns depends upon the correct working of the fuse attached to the projectile. A defective fuse would probably not only fail to plosion until the gun is fired. It is, of course, necessary that the hole is of proper diameter and depth. The fuse body is dropped into the jig as shown in the sectional view, and located on the center bolt as shown. The center bolt is drilled, hardened and lapped, and acts as a position stop, and as a guide for the drill when drilling the flat bottomed hole. The jig is provided with a movable plate and a screw plunger, which are removed from the jig to allow the fuse to be put in and taken out. The screw only requires about one turn to fasten the fuse in position. The jig is also provided with two extracting levers which are necessary to extract the fuse after drilling, owing to the close fit of the fuse in the jig. The three holes are all of different dimensions, and as two drills are used for the flat-bottomed hole, the work is done on a

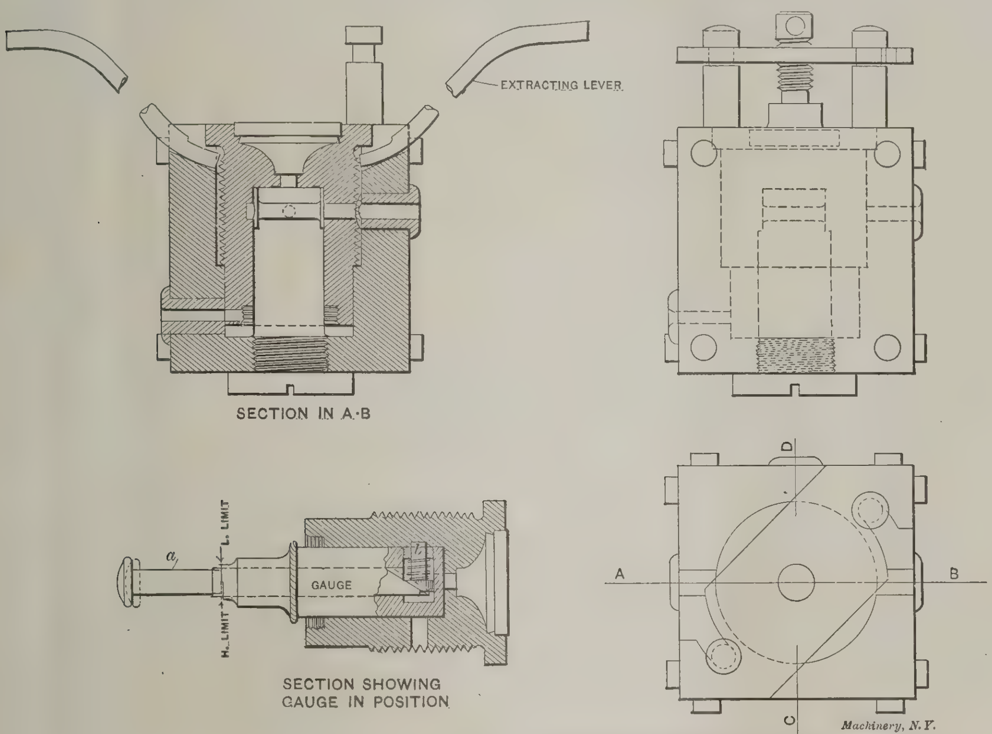


Fig. 1. Jig for Drilling Percussion Fuse, and Gage.

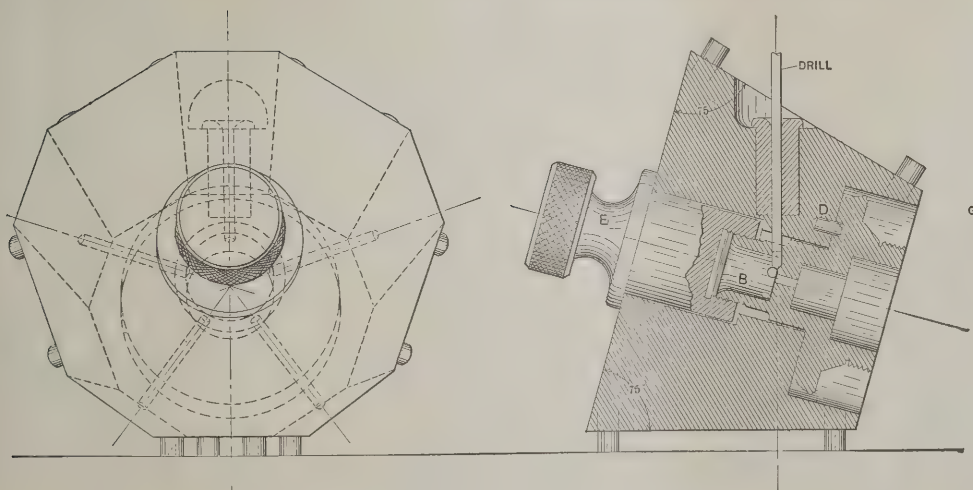


Fig. 2. Jig for Drilling Angular Holes in Percussion Fuse.

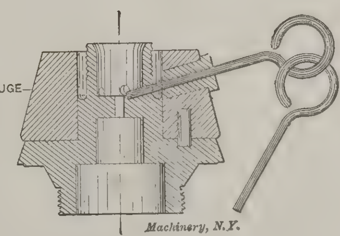


Fig. 3. Gage for Testing Angular Holes.

act at its destination, but would be liable to explode the shell either before it left the gun, or at so short a distance away from it that the operators themselves would be in danger of annihilation or the gun itself damaged to such an extent as to be of no further use. There is, therefore, a grave responsibility resting upon those engaged in the manufacture of this class of work. Fig. 1 is a plan, elevation and sectional view of a jig for drilling three holes in a percussion fuse, and as will be seen in the section showing the depth gage in position, one hole passes right through the wall and for a short distance into the other side of the fuse, forming a flat bottomed recess which acts as a locking chamber for a centrifugal bolt which renders it entirely safe from premature ex-

four-spindle drill press and all holes drilled at one setting, which ensures accuracy and speed. When the first hole is drilled a safety peg is pushed in to guard against any chance of the work moving during the drilling of the other holes. The method of gaging the flat-bottomed and most important hole will be readily understood from the cut. The plunger *a* is pressed down, pushing the plunger *b* forward, and if the hole is not of correct depth, it is immediately detected by the limit step on the body of the gage. If the hole is not at its correct distance from the bottom of the bore, which is very important, it is impossible for the plunger *b* to enter.

Fig. 2 shows a jig for drilling five holes in the stem of a time and percussion fuse at an angle of 75 degrees to the cen-

terline. The fuse body *B* is pushed into the jig from the front end and located by the position peg *D*, which serves the double purpose of locating the five holes in their proper position, and of preventing the fuse from turning during the drilling operation. The tightening bolt *E* is then screwed on the stem of the fuse and in conjunction with the position peg *D* holds the work perfectly secure. One of the five bushings in the jig is shown in section. The bushings are hardened and lapped, and are purposely made long, because when the drill breaks through the walls of the fuse body, it has to travel on a considerable distance to drill a half-round groove along the flat-bottomed cavity of the fuse stem. It is therefore desirable to have a good bearing to keep the drill up to the work. The method of gaging this operation is shown in Fig. 3. The gage is pushed on the fuse stem and has a position peg which fits a hole in the fuse; by the aid of two wire gages, the angle as well as the diameter of the holes are gaged.

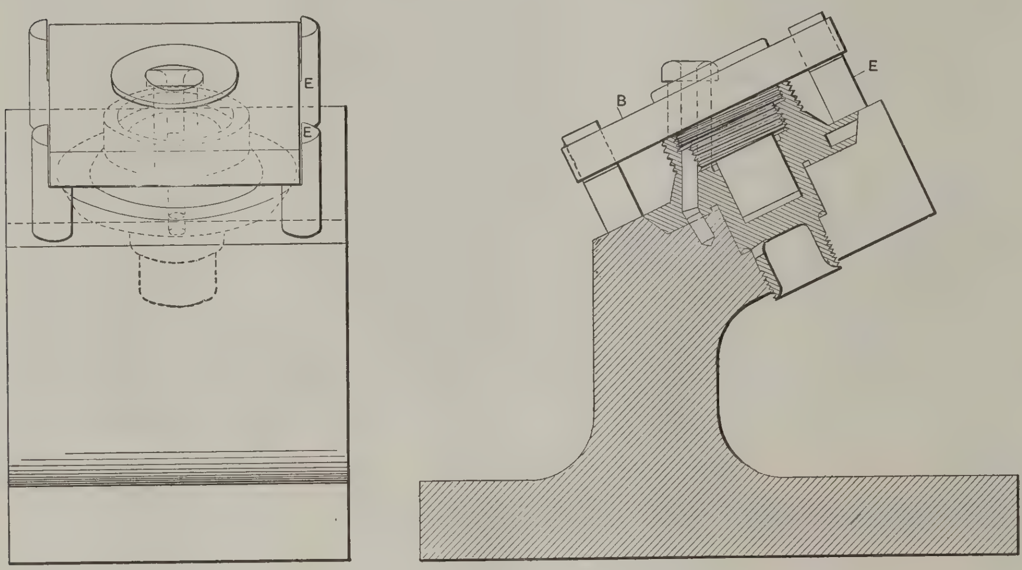


Fig. 4. Jig for Drilling Angular Hole in Percussion Fuse.

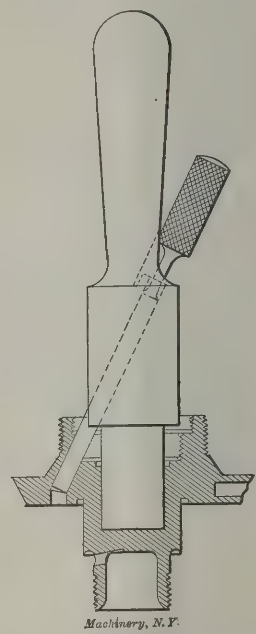


Fig. 5. Gage for Testing Angular Hole.

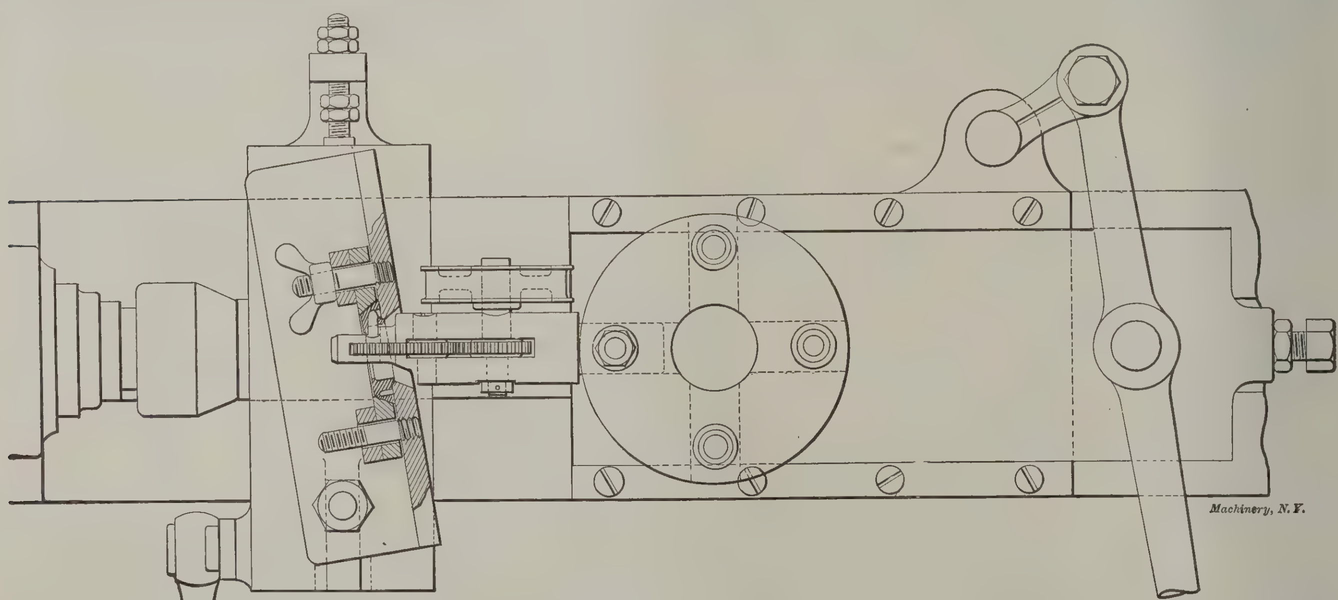


Fig. 6. Method of Drilling Firing Rings.

Fig. 4 shows another jig for drilling a hole in a time and percussion fuse at 25 degrees angle, and of a given depth to meet another hole running parallel to the axis of the fuse.

The fuse body is dropped into the jig and on to a position peg as shown, this being all that is required to keep the work in position. The drill bushing is mounted in a square plate *B*, which is held in position by the four upright standards *E* and provided with a stud entering the inside of the fuse body. The method of gaging the angle is shown in Fig. 5 and is a very severe test. In my experience (and I have been engaged in this class of work for years), I have never seen a jig which did better or quicker work than this one, and to those not engaged in this class of work, these special operations may be very interesting.

Fig. 6 shows a way of getting over what looks at first as a rather difficult job which had to be done in the shortest possible time, and without the aid of any expensive special machinery. The cut shows a firing ring for a time and percussion fuse fixed in position to have a hole drilled from its bore outwards at an angle of 81 degrees into the firing channel on the face of the ring. As the ring could not be drilled from the outside, I discarded any idea of using a drilling machine and jig for the purpose. I decided to use a screw machine with cross slide, and had a small fixture made to carry a train of gears to be driven from the countershaft above. I made the drill the axle for the smallest of the gears in the train, and by fixing a drum on the countershaft the belt was enabled to travel backward and forward and to follow the movement of the cross slide. The hole to be drilled was 0.157 inch diameter ± 0.002 inch. The drilling fixture had to be nicely fitted up and wearing parts hardened and ground to prevent backlash or poorly fitting surfaces. The fixture was mounted in one of the holes in the turret as shown in the cut. The holder for the firing ring was an angle plate bolted to the cross slide at the angle required, viz., 81 degrees. The firing ring being

cone shaped on the outside, I had the plate *A*, Fig. 7, made with a hole bored out to drop over and slide on to the ring, and a packing piece *B*, Fig. 7, to drop on and take up the space that the plate *A* required to slide back to clear the ring. This saved a lot of time inasmuch as it obviated the necessity of a lot of screwing up and unscrewing every time a ring was drilled. With these plates one half turn of the wing nuts was sufficient to loosen the plates so that the finished firing ring could be removed. When the firing ring was

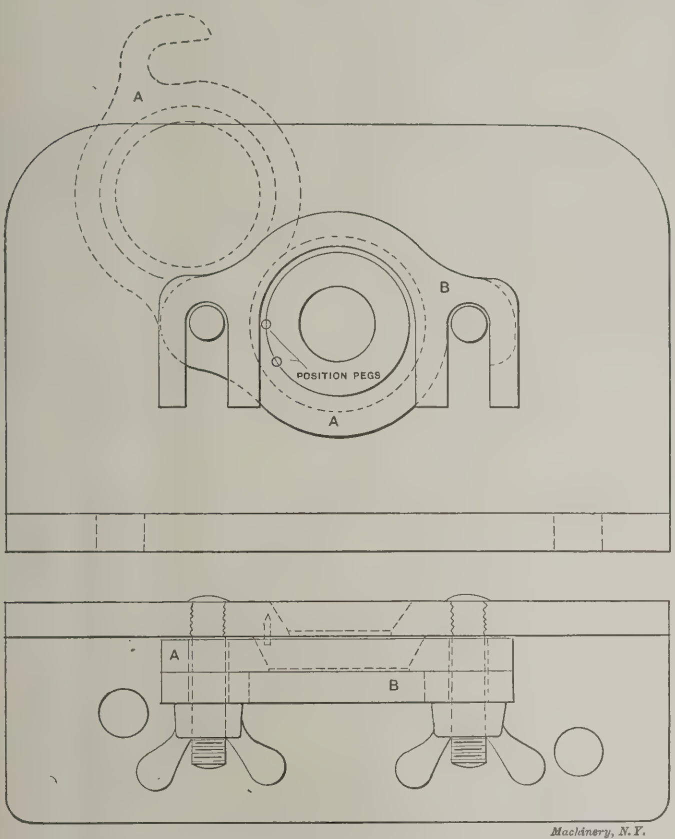


Fig. 7. Detail of Holding Device for Drilling Firing Rings.

fixed into position the operator had simply to move the cross slide back to its stop with his left hand, and, holding it there while he moved the turret slide forward to its stop with his right hand, he again moved the cross slide forward, bringing the work toward the drill until it reached its forward stop. He then simply reversed the movements and the job was done.

The countershaft was operated with the foot so that the drill was not running while change of work was going on, which

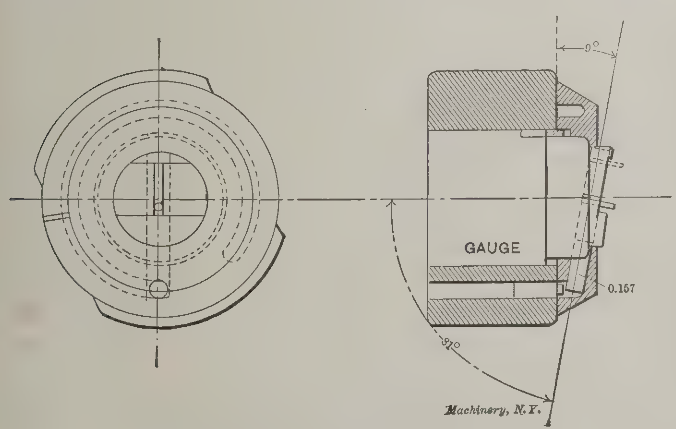


Fig. 8. Gage for Testing Hole in Firing Ring.

obviated a lot of unnecessary wear. The work came out with the greatest accuracy, the fixture gave no trouble, and one operator was able to drill 3,000 of these firing rings per day with comfort. Fig. 8 shows the method of gaging the angle of the hole, and it will be seen that if the work was not correct, the gage would very soon find it out. The diameter of the hole was gaged with a hook gage with maximum and minimum diameters on respective ends.

TRACING, LETTERING AND MOUNTING.—3.

I. G. BAYLEY.

Mounting.

Mounting Tracing Paper.—Tracings likely to be in hand a long time should be mounted to the drawing board, for several reasons. They will be protected from getting torn and will not shift on account of the sudden change of temperature of the room which may take place; they can also be cleaned more safely than if held by a few tacks.

The paper should be cut large enough to allow for sticking the edges to the board and should it be intended to color the tracing with liquid colors, twice the allowance should be made as the paper will be cut after the tracing is made, and mounted the second time.

The drawing to be traced should be laid down square with the board, perfectly flat and level, then thoroughly dusted down to remove all obstructions, as these cannot be removed after the tracing paper is mounted.

A long, flat straightedge with a couple of weights for each end is needed. Having cut the paper, dampen it slightly with a wet sponge, going over it very evenly and working quickly, so that it may be attached to the board before quite dry. The damp side must be up. The straightedge is placed an inch outside of the cutting-off line and the weights put on, one at each end. Turn up the edge of the tracing paper as shown in Fig. 22 and apply the mucilage or paste brush, pressing the edge down firmly with a straight-edged ruler or paper knife. The opposite side of the tracing paper is treated in the same way, and then the two remaining sides, care being taken to stretch the paper carefully by pulling the edge of the paper gently with the tips of the fingers, before the weights are put on the straightedge.

Any superfluous water may be removed with a blotter. The whole operation, as before stated, should be done very quickly, as in a warm room the paper soon dries.

Mounting Paper for Coloring.—Should there be any wash coloring to be done after the tracing is made, it is usually done on the back. The tracing is therefore taken up, cutting close to the pasted edge, so as to leave as much margin as possible for the second mounting. The drawing paper is also

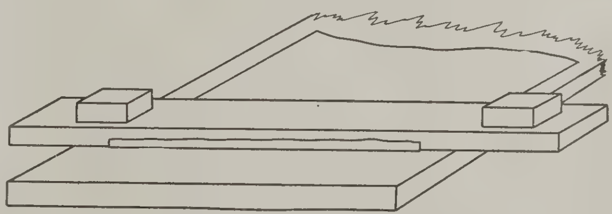


Fig. 22. Mounting Tracing Paper.

taken off the board and a clean white sheet not so large put in place of it. The tracing paper, being turned over, is again mounted to the board as previously described, care being taken to get no paste inside the cutting-off line, which should have been distinctly marked. While the paper is drying the colors can be mixed. Allow the coloring to thoroughly dry before cutting off the tracing, which should be done with a sharp knife, following the cutting-off line very carefully.

Mounting Cloth for Tracing or Coloring.—The process described above is for paper tracings only. Cloth can be mounted in the same way except that on no account should a damp sponge touch it, but it may be stretched without damping it at all, though not so satisfactorily. If the tracing cloth is put in a cold or slightly damp place over night it can be stretched very nicely, using a thin glue instead of paste. When one edge is firmly fixed, the other should be pulled very tight and extra weights put on the straightedge to hold it in place while applying the glue brush. Mounting for coloring is done the same way, it being, of course, understood that the coloring is done only on the dull side of the cloth.

Very satisfactory results can be obtained by not mounting tracing cloth at all, but simply using a number of iron tacks driven with a magnetized hammer elsewhere described.

Mounting Blueprints, Maps, etc.—Blueprints, maps, draw

ings, old tracings, etc., are often mounted on linen or cotton to preserve them. The linen or cotton should be cut larger by several inches than the blueprint and a drawing board about the same size used. Soak the linen well in water, rinsing it out between the hands until all the superfluous water is squeezed out, when it should be unfolded and shaken out. Lay it across the board and commence tacking one edge, beginning at the center and pulling gently; place a tack about every two inches along the edge of the board, as shown in Fig. 23. The other half of the same edge must be done in the same manner. The opposite edge is done next, stretching the linen well each time before a tack is driven; commence at the middle as before and work toward each end. The two remaining edges are done in exactly the same manner, and all is now ready for the paste, which should be prepared for use before the linen is stretched. The paste can be made either of starch or flour. A sufficient quantity is mixed in cold water to about the thickness of cream. Hot water is then poured over it, gently stirring it meanwhile; the whole is then put back into the saucepan and stirred until it begins to boil over, when it is lifted from the fire, poured back again into the basin, and is ready for use. An apron of some kind is fastened around the neck reaching to the knees to protect the clothes from getting soiled. Taking some of the paste in the hand, slap it over the board, rubbing it well into the linen with both hands, using more paste if required until the whole surface is covered. Now, commencing at the lower edge and at the left-hand end, holding the tips of the fingers close together push the superfluous paste along to the center of the board as you travel along from left to right. Go to the opposite side of the board and do the same thing, forming a ridge of paste along the middle of the board, which is scraped off with

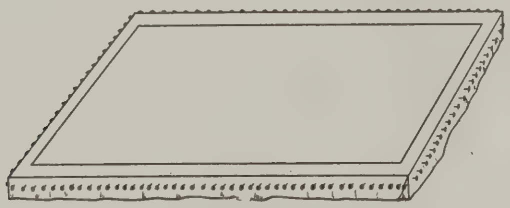


Fig. 23. Mounting Blueprints and Maps on Linen.

the hand into the basin. With both hands go all over the board again until the paste is nice and evenly spread all over the linen.

An assistant is now required. The blueprint is dampened on the back with a sponge and placed gently in correct position on the linen. One half is to be pasted at a time. The assistant holds it up by the two corners at an angle of about 30 degrees while with a large blotter in one hand held to the print you rub gently but firmly over it, the assistant letting the print gently yield to the pressure you bring to bear upon it. Passing over to the other half, it is lifted from the board and then treated in the same way. Wherever an air bubble appears it can be pricked with a needle, and the blotting pad placed over it, while with a circular sweep of the other hand you press it firmly to the board. Should any obstruction unfortunately have been left between the print and the linen a slit can be made in the former and the obstruction removed when it is again pressed to the board.

The whole should thoroughly dry before any attempt is made to tear it from the board. Often this is not done till the following day. Cut through the print and linen with a sharp knife along the cutting-off line all around the board. Then, lifting the corner, pull gently but firmly in a slanting direction. The tacks and trimmings are then removed and the board cleared away.

The case of a blueprint has been taken. Maps, drawings, etc., are done in precisely the same manner.

Before the print is taken up a coat or two of clear copal varnish is sometimes applied to preserve it still more.

Mounting Paper to Drawing Board.—A quick and very satisfactory way of mounting drawing paper to the board instead of using tacks is resorted to by many draftsmen in the following manner:

The paper is laid flat on the board, right side up. A moderate sized sponge filled with water is wiped all over the surface of the paper within an inch or so of the edge all around. The superfluous moisture is mopped up with the sponge and the edges then dampened.

One half of the sheet is turned precisely over the other half, edge for edge. With a well-filled mucilage brush go quickly around the three edges of the upturned half of sheet, and turning it over again, press the edges firmly to the board with thumb or a flat, thin stick. Turn the other half of the sheet over the first and proceed in the same way. When thoroughly dry the paper will stretch very satisfactorily.

Still another way of mounting paper is to lay the sheet down *wrong side up* and with a small glue brush dipped in liquid glue go all around the edge of the paper at once. Quickly sponge all over the surface with plenty of water, keeping clear of the glued edge. Having mopped up the superfluous moisture with a dry sponge, turn the paper completely over and stretch it to the board by going over the surface with the flat of the hand or a clean, dry duster, working from the center to the edges, pressing the latter all around firmly to the board with the flat of the thumb or a thin, flat stick or ruler.

Either of these methods has been successfully used in many offices, especially architects, but for important work the method described under the head of "Mounting Tracing Paper" and illustrated in Fig. 22 should be resorted to.

* * *

THE APPLICATION OF FOUNDRY BLOWERS.

The general application of a pressure blower of the fan type to a cupola is too well known to require description; but certain features which relate to its efficiency often escape attention. The proportions of a pressure blower wheel should theoretically be such that its capacity area or square inches of blast shall be practically equal to the free area through the fuel and iron in the cupola, less the influence of the resistances of piping, tuyere boxes, fuel and iron. These resistances are evidently the equivalent of just so much reduction in area, and must therefore enter into any consideration. But it is manifestly true that differences in the length and arrangement of piping in different plants, and of size, quantity and character of the charges in the same plant, introduce such variable conditions that it is impossible to design a blower of any type that shall at all times be just *exactly* proprotioned to the work to be done. For this reason the exact power required to operate any given blower cannot be given as an absolute quantity, but can only be determined when all of the conditions are known.

It is, or at least it should be, customary in specifying the pressure required to operate a cupola, to refer to that in the windbox. On the other hand, the table of blower speeds presented in the authoritative catalogues published by the B. F. Sturtevant Co. gives the number of revolutions necessary to produce the given pressure at *the fan outlet* when its area is within the capacity of the blower. Owing to losses due to transmission, this pressure cannot be maintained at any more or less distant point, such as the windbox of the cupola, unless the speed of the fan is increased sufficiently to produce an excess of pressure equal to the transmission loss.

It is the failure, on the part of the purchaser, to comprehend this fact, and to make due allowance for transmission losses, that sometimes results in too low a pressure at the cupola, and in unjust charge against the blower. Large, straight and short connections from blower to cupola are always imperative if waste of power is to be avoided. If changes in the direction of the piping are necessary, they should be made with as large a radius of curvature as possible. It should be distinctly understood that the power required to operate a fan blower is proportional to the area of discharge. If this area be reduced to zero, by the closing of the blast gate, the power will be reduced to merely that due to friction of the machine and the air confined within the case. Too often it is claimed, by those who ought to know better, that closing the pipe increases the power; but, as power is expended only when air is moved, the fallacy of this statement is evident.

SHOP PHOTOGRAPHY.

H. P. FAIRFIELD.

One of the most valuable and interesting phases of picture-making with the camera is what is commonly termed "shop photography"; that is to say, pictures of machinery either in operation or under construction. Where a machine is photographed for catalogue purposes it is usually painted and posed for the occasion and can be put in a selected light. Such work as this does not properly come under the head of shop photography, but is true machine portraiture.

Technical publications, such as MACHINERY, are making an increased use of shop photographs, and no small part of their popularity is due to the willingness to use camera results. How firmly a picture fixes a result in your mind! Take for example a "Weak Steam Fitting," shown on page 486 in MACHINERY for May, 1906. The eye catches this at once, and it is doubtful if the reader can ever forget the result of a use such as described. Besides this, it has called his attention to what he may expect under like conditions. Along this same line may be noted perhaps hundreds of similar cases where the camera has fixed for the readers a record of some device or called attention to some happening of general interest and value. As an example of what the camera has done for the manufacturer, consider the advertising matter of, say, the Cincinnati Milling Machine Co. In such cases as this the photographs represent the manufacturers' own practice and only what may be viewed direct by a visit to his works, if this were possible.

In machine construction of certain kinds, the camera tells the story of progress to those interested as no other means can, and many firms use such records on work being built or erected or going forward away from their immediate view. The Brown Hoisting Mchy. Co., of Cleveland, Ohio, are a notable example of this use of "shop" or "record of fact" photography.

The writer's use of the camera began about fifteen years ago with the taking of several views of a wreck due to a flywheel explosion in a wire mill, and has continued with increasing interest till the present time. Photographs have been sought wherever anything novel occurred, where machines were in use, and, in fact, whenever a record of fact was desired. Examples of old and interesting machines have been sought and recorded, and in this manner the progress of the designer's art is shown.

To the readers of MACHINERY it is probable that shop photography is most interesting from the aspect of its application.

First: For purposes of illustration and explanation relative to what may be expected under actual working conditions.

Second: Progress of construction or erection. To achieve satisfactory results in either field requires a good outfit and much careful, painstaking work.

In no other line of camera work will conditions relative to a proper lighting of the subject be worse than are often found in shops, when one considers that the exposures must be made just as things are found. However, satisfactory results can be obtained under any and all conditions by the exercise of good judgment and a knowledge of all the ins-and-outs of photography.

The pages of technical publications show that nothing is too difficult if the object is worth attainment. Pictures are seen which have been made with the camera set on the cylinder of a steam engine, on the running board of a locomotive traveling at high speed, under mills with the camera set on thin ice; in fact, no place is too hot or too cold for the ambitious worker—"the man behind the gun"—if he is provided with a suitable outfit.

A camera that will produce negatives of a size ranging between 5 x 7 inches and 8 x 10 inches is suitable for this work and should have a bellows draw that will permit the use of lenses with a length of focus equal to twice the *long* side of the plate used. For this purpose the writer prefers to use two cameras, one of 5 x 7-inch size and one 8 x 10 inches. The use of wide angle lenses must also be considered when the camera is purchased, as it should be possible to use lenses with a length of focus equal to or less than the *short* side of the plate used.

While the camera box is important, it is to the lens that we must look for the picture, and a good set of lenses is indispensable. A Zeiss Convertible VII. A. set is an excellent lens for the purpose, as the doublets are made up of two single combinations that are corrected for astigmatism, spherical abberation, and are rectilinear and practically perfect lenses each, when used alone. When used as a doublet the length of focus should approximate the long side of the plate they are used on and the single combinations should have a length of focus equal to one and one-half and two times the length of the long side of the plate. In addition to these, a doublet with a length of focus equal to, or less than, the short side of the plate should be provided. These should all be fitted to interchange in a good "between the lenses" shutter, provided with a bulb and tube sufficiently long to permit standing a convenient distance from the camera while making the exposure.

The picture depends, to a great extent, upon the viewpoint from which it is taken, and the length of focus of the lens used. If the machine is taken broadside on, the effect is usually grotesque, and the same may be said of strictly end views; however, as the operation or construction to be photographed will seldom admit of a choice of views, it becomes largely a question of which lens to use. To this end, bear in mind that the shorter the focus of the lens used on a particular plate, the more the perspective is magnified, and *vice versa*, the longer the focus the more nearly correct is the perspective.

Little can be done relative to lighting, as the light must usually be taken as found; however, at times, a choice is possible, and something may be said on this point. Bear in mind when setting up the camera: *a*. That the light should not come from the front, but from behind. Strong light in front *must* be screened off. *b*. Strong light from any point is to be avoided, as it begets heavy shadows, and a dull or rainy day is to be preferred to brilliant sunshine, unless some means for screening the windows is provided. *c*. That the light which enters the lens should be reflected light coming from the surfaces photographed, and that the dark surfaces and shadowed portions reflect but little actinic light. Use double-coated, non-halation plates, expose for the shadows and develop with a pyro developer, at least until you become an expert operator. Study your negatives and prints for the lighting, the effect of the perspective, the length of exposure given, and the development. Keep at this until you know a good negative when you see it, also how to produce such a one; study the picture upon the ground glass when selecting the view point and lens to use, as that represents the way the lens sees it.

As a short summing up, the description of an outfit that has been in use for four years and was bought after considerable experience with various combinations, may place the subject before the reader most clearly. The camera box is known as a 5 x 7-inch, and has all the usual adjustments, with a bellows sufficiently long for any of the lenses of a No. 8 Zeiss convertible lens ground by the Bausch & Lomb Co. Used as a doublet, the focus is 7 inches; front combination, 14 inches; back combination, 11½ inches; which interchange in a Bausch & Lomb shutter lens of 4¾-inch focus. The tripod is of the single-slide type, heavy enough to be rigid and stable under severe conditions, even when used to carry an 8 x 10-inch box. This outfit is practically duplicated in the 8 x 10 size, as a 10-inch focus lens is used upon an 8 x 10-inch plate and a 19-inch focus wherever the conditions will permit. A study of camera catalogues will teach the user that there are many helps in the line of simplifying his labors if his means will allow of their purchase. For instance, a flash-lamp outfit is a great help in dark situations, but it needs to be used with good judgment and a knowledge of its limitations or the results will be grotesque. Do not buy an advertised help until you know something of it, and then only when you can see its value in your own work. Study up on lighting, chemistry of the developing and printing processes, the design, construction, and physics of photographic lenses and ever stand ready to honestly compare your work with that of other workers, aiming at improvement always.

PORTABLE TOOLS FROM EUROPE.

Portable tools have been brought to a high state of development in Europe and are widely used for general manufacturing. Advantage has been taken of the electrical drive in many ways, for various purposes and with the leading idea to reverse the ordinary practice; instead of carrying heavy work to the machine tools, where it has to be set up and fastened for machining and removed again after the work is done, effective tools working with utmost precision are brought to the piece and attached to same, the machining is done with or without jigs in one setting. This always saves time and in a great many cases operations can be performed with these tools that would otherwise require special and costly machines.

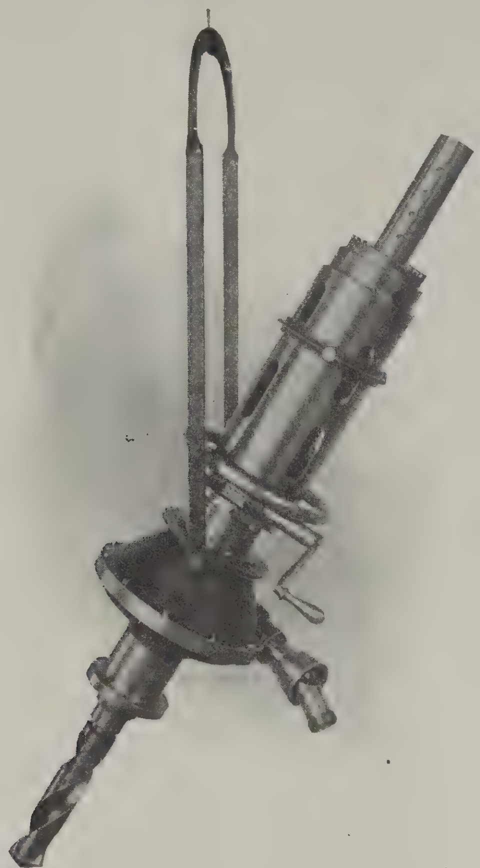


Fig. 1. Drilling Spindle without Base.

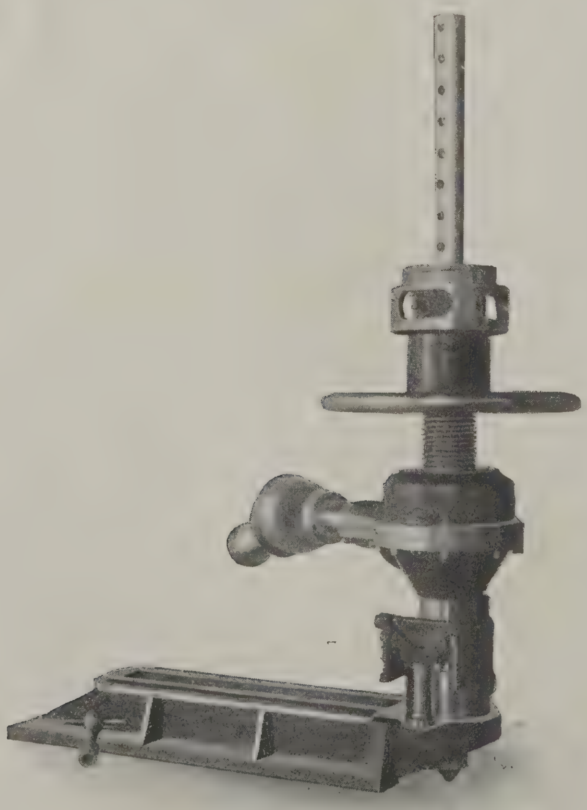


Fig. 2. Drilling Spindle Clamped to Slotted Base and provided with Extensible Drill Spindle.

It was the general custom to use portable tools only in places where no other means were available, where a bracket or similar part had to be attached which was not provided for on the drawing and in other such instances. With the European tools it is different, they count just as much in the process of manufacture as any stationary machine with the only difference that they are more adaptable.

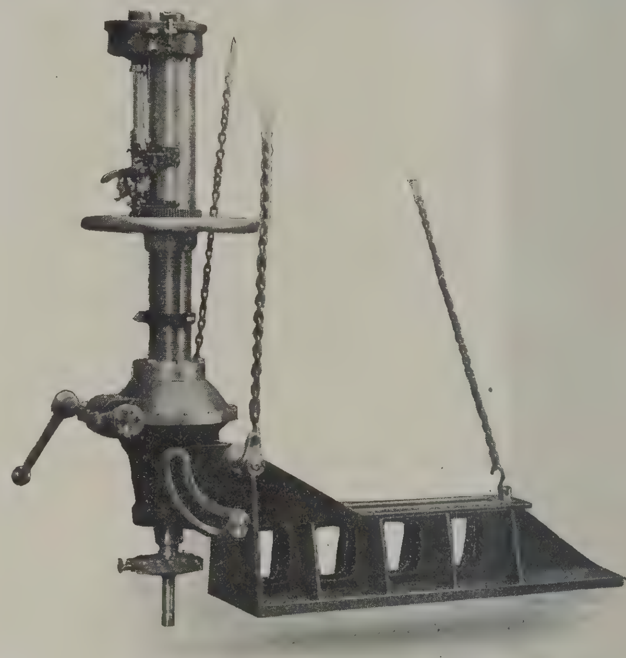


Fig. 3. Capitaine large size Portable Milling and Drilling Tool.

The milling and drilling tools illustrated consist mainly of a work spindle, driven by means of a telescopic shaft from a portable electric motor. This spindle may be clamped to a jig or to the work itself by means of a very simple device. Fig. 1 shows a drilling spindle suspended; Fig. 2 a drill spindle clamped to a slotted base. A series of holes is drilled into a flat plate, by clamping the base *A*, Fig. 4, to the plate by means of a screw-clamp *c* and after one hole is drilled this is used to hold the base with a bolt. From the illustrations can be seen that the drill is guided by a suitable bushing *i*, close to the hole, which in combination with the flat base *A* insures a perfectly true and accurate drilling. The same cut shows in the upper view how bosses inside of side frames may be finished with the same appar-

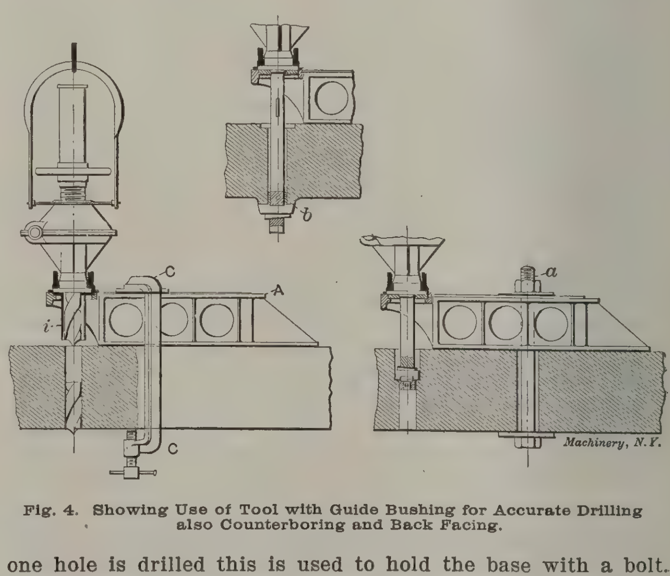


Fig. 4. Showing Use of Tool with Guide Bushing for Accurate Drilling also Counterboring and Back Facing.

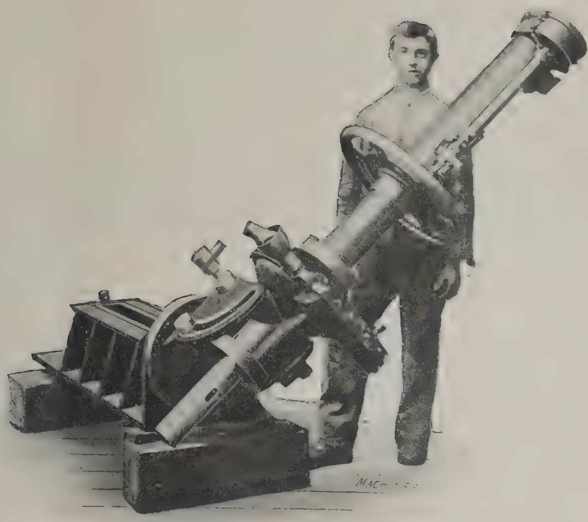


Fig. 5. Large Size Portable Milling and Drilling Tool.

atus. When very deep holes are to be drilled, or the hole, which is to be drilled is some distance away from a suitable place for clamping the base, the drill spindle can be lengthened indefinitely, by moving a pin in its upper end from hole to hole, as may be seen from Figs. 1 and 2. The larger portable spindles are provided with automatic feed and stop, which permits drilling or milling under any angle. Figs 5 and 5*a*, which illustrate this, also illustrate to what large dimensions these tools are built. Fig. 6 is the same tool at work drilling a big dynamo frame. These large sizes are suspended and balanced, but the smaller ones can easily be lifted by one man.

A few more illustrations will show the general adaptability of the system. A special base with slide-rest is provided for milling seats with toothed or other milling cutters, Fig. 7, and clamping one of the larger spindles to it. By providing two upright posts on a floorplate, Fig. 8, it serves as an efficient horizontal boring machine. Fig. 9 shows a portable spindle clamped to a jig, *c*, for drilling the holes *b* and milling the valve seats *a* in one operation.

Another application of this system of portable tools is the boring of large cylinders. The boring bar of Fig. 11 is principally used for boring locomotive cylinders in place; it may be used for any length of cylinder as the spindle length is unlimited. The feed and stop are automatic, by means of two rollers pressing against opposite sides of the boring bar;

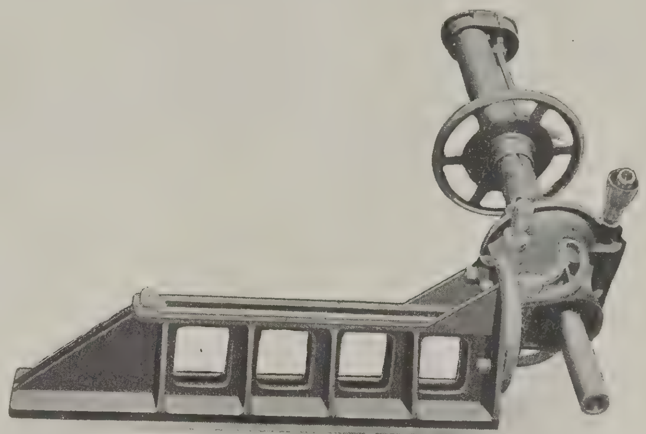


Fig. 5a. Large Size Portable Milling and Drilling Tool.

these are driven by a worm gear. Figs. 10 and 12 show a similar tool for boring and facing gas engine cylinders.

A special tool for milling steam ports in Corliss engine valve chests and which also is driven by a telescopic shaft and electric motor, is illustrated in Figs. 13 and 14. The

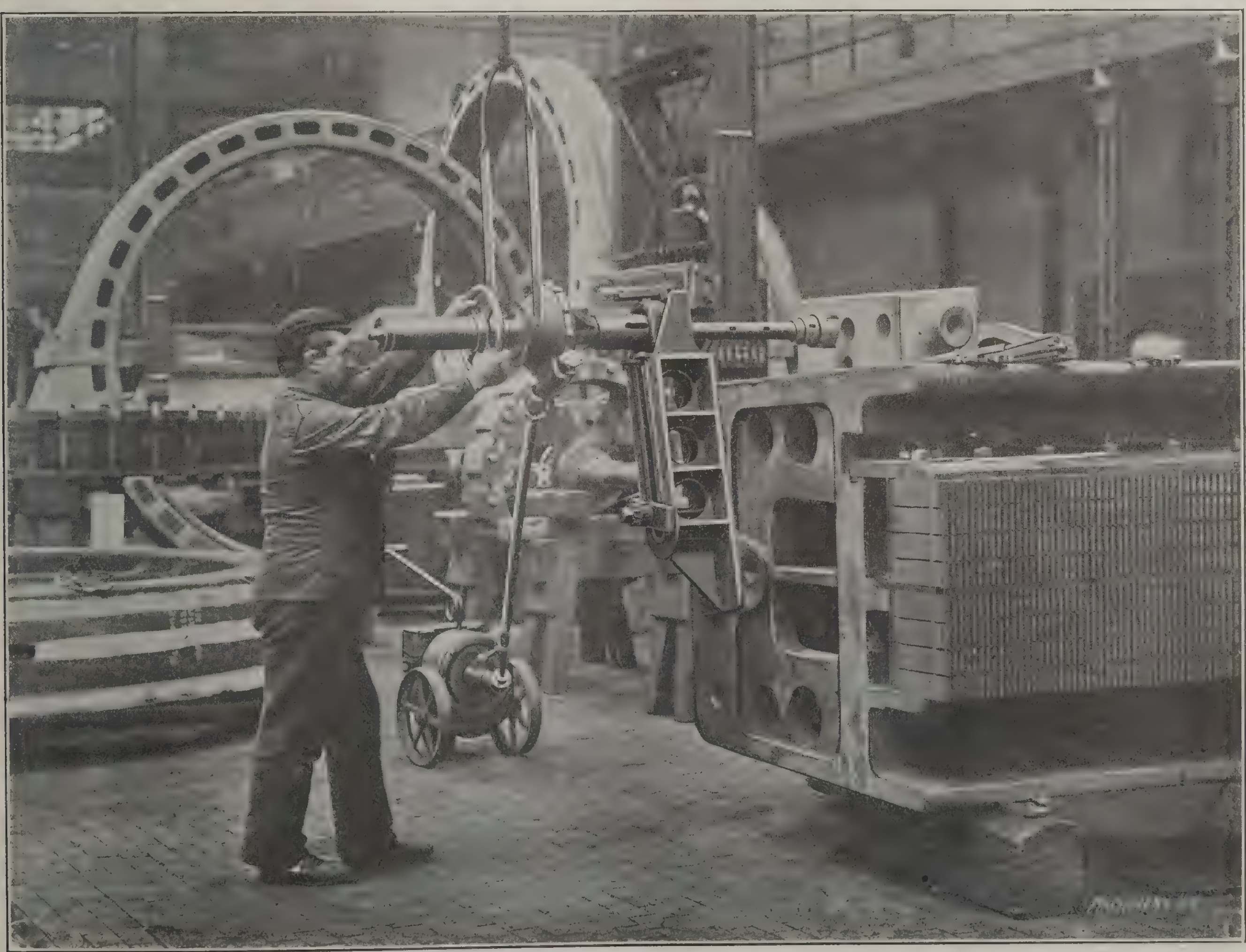


Fig. 6. In Use Boring Holes in a Large Dynamo Frame.

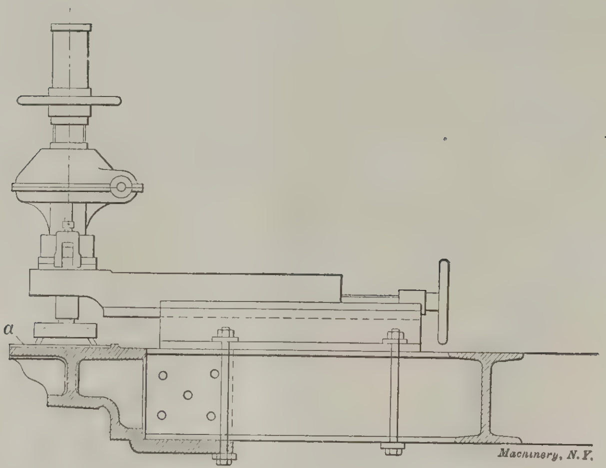


Fig. 7. Milling Tool provided with Slide-rest.

carriage *B* moves in the groove of the tube *A* automatically, being driven by spindle *D* and a sliding helical wheel which meshes into the pinion on the milling spindle *C*. The transverse adjustment is accomplished by a long wrench *p* from the outside, turning shaft *o*, which transmits its motion by a worm and wheel to the adjusting screws *c* and *e*. The parallel milling of the ports is secured by two eccentric discs *E*, which fit into the bore of the valve chests.

There are many more applications of these tools for special purposes, of which we have shown a few. The designers and builders of these tools are Messrs. Emil Capitaine & Co., Frankfort-on-the-Main, Germany, and Mr. M. Joachimson, 14 Church Street, New York, is their American representative. The De La Vergne Machine Co. recently installed a number of these tools in their shops and others are in preparation.

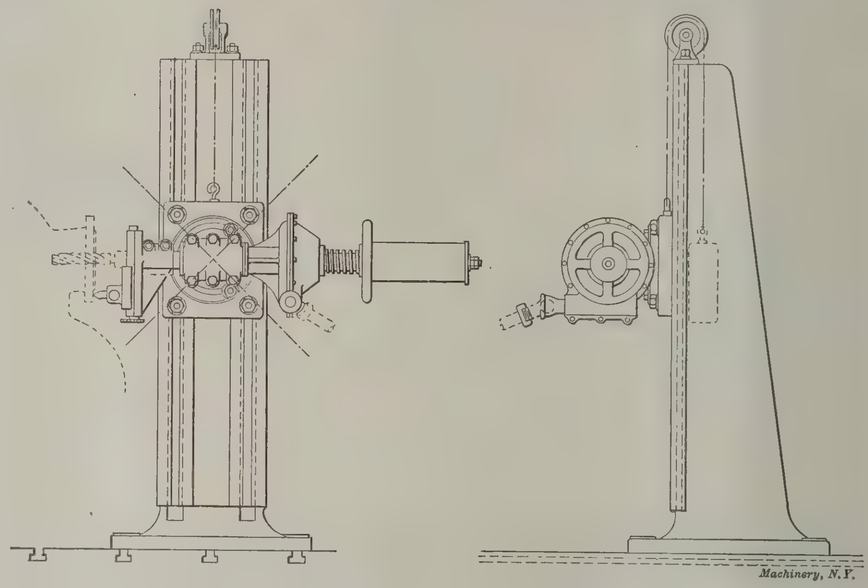


Fig. 8. Use of Portable Tool as a Boring Machine.

* * *

A new bridge of imposing dimensions will be built across the St. Lawrence river at Montreal in the immediate future. It will be a cantilever bridge with a main span 1,500 feet long, 150 feet above the water. The bridge will have accommodation for railway and trolley tracks, as well as for horse and passenger traffic. From end to end the bridge will be two and a half miles in length.

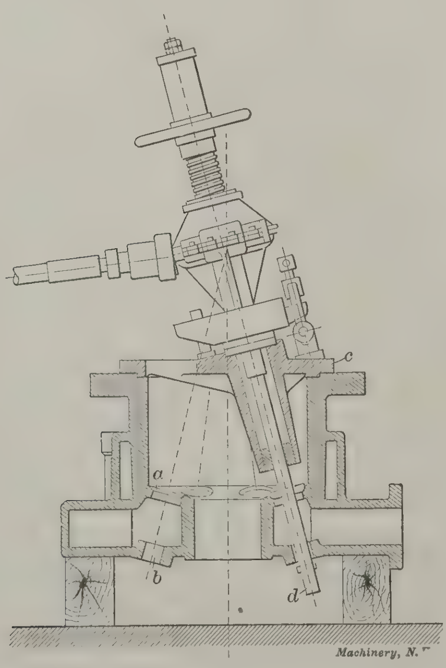


Fig. 9. In Use in a Jig, Boring and Milling Valve Seats at an Angle.

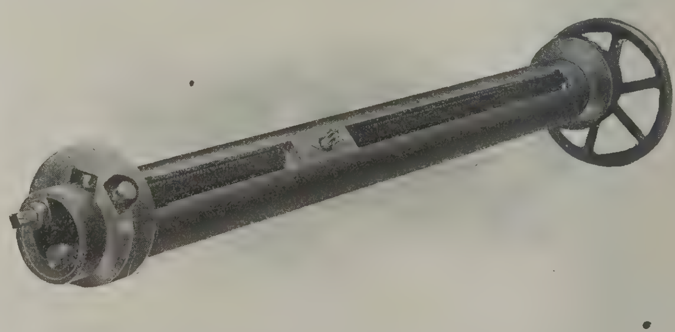


Fig. 13. Portable Tool for Milling the Ports of Corliss Engine Cylinders.

TECHNICAL EDUCATION IN EUROPE.

In his article "An Experiment in Industrial Engineering," in the September issue of MACHINERY (Engineering Edition), Mr. Alexander expresses the belief that the efforts which the General Electric Co. and other concerns are putting forth to train boys in various trades, must be considered "as experiments only, highly important as an immediate remedy; but these are experiments which the state ought to watch with a deep interest, in order to draw therefrom proper conclusions as a foundation on which to build the right system of industrial education." He expresses his belief that the public school system should adapt itself to modern industrial conditions by at least starting boys, who are to work with their hands for a living, in the way of gaining familiarity and efficiency in the handling of the tools which they are to employ when they leave the school and enter the factory. The extent to which this idea has been carried in some continental countries is a matter of record. We were given a fresh and vivid impression of this condition, however, in a recent conversation with Mr. Arthur Williston, the director of the Department of Science and Technology in Pratt Insitute. Mr. Williston has just returned from an extended visit to the various trade and technical schools of Europe.

The population of Switzerland, for instance, is 3,315,000; that of Massachusetts is slightly over 3,000,000. Switzerland, which we are accustomed to think of as primarily a land of wild mountains and unfertile soil, with the fleecing of tourists as its chief industry, has within its boundaries over 300 technical schools of various grades. The data for the number in Massachusetts are not at hand for the moment, but whoever is at all acquainted with this most highly developed of our manufacturing commonwealths would hesitate to put the number at more than 10 or 15 per cent of that given for its European rival. The figures given for Switzerland include, of course, institutions of all grades—trade schools, elementary and higher technical schools, and engineering colleges. One of these latter, the Polytechnikum of Zurich, compares in equipment and number of students with our

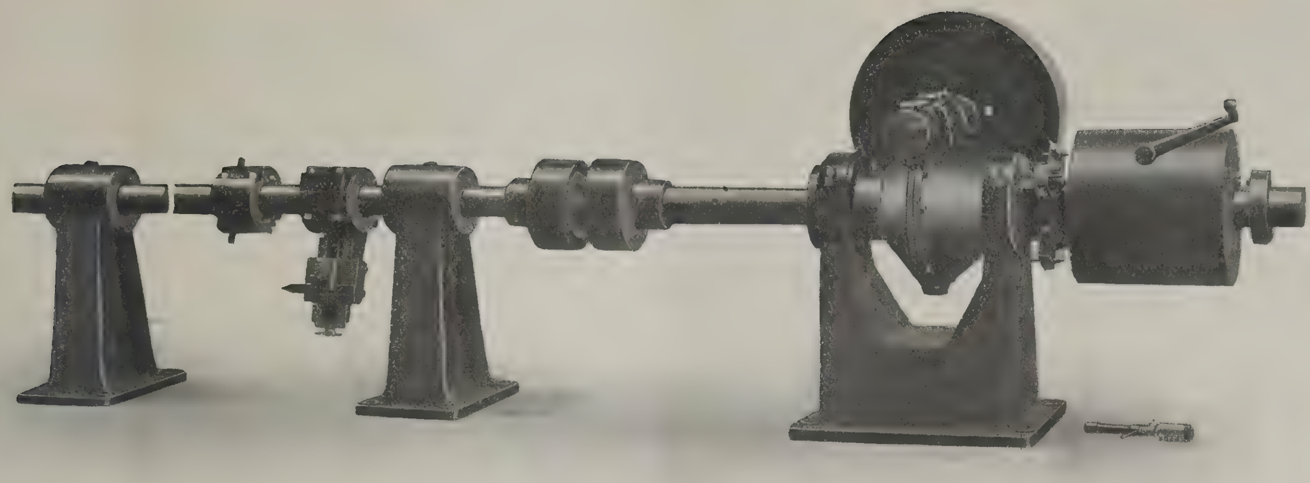


Fig. 10. Portable Boring Machine for Engine Cylinders.

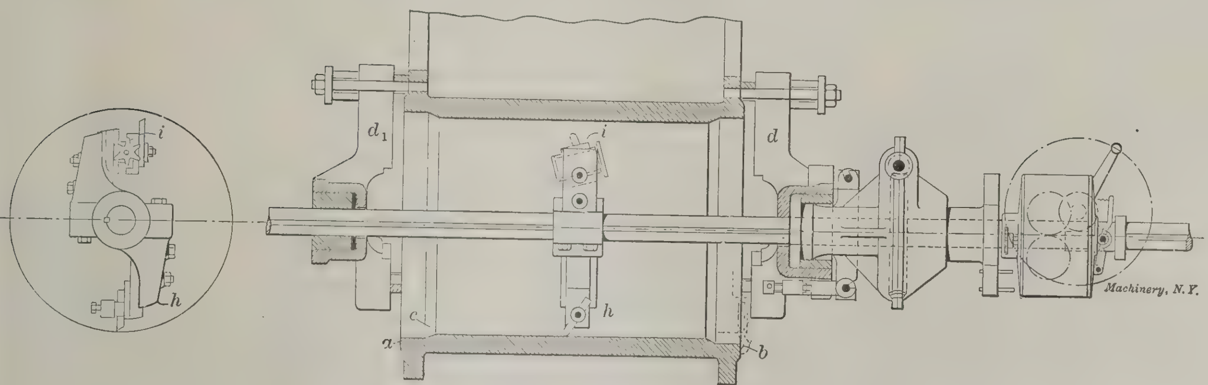


Fig. 11. Capitaine Portable Boring Machines

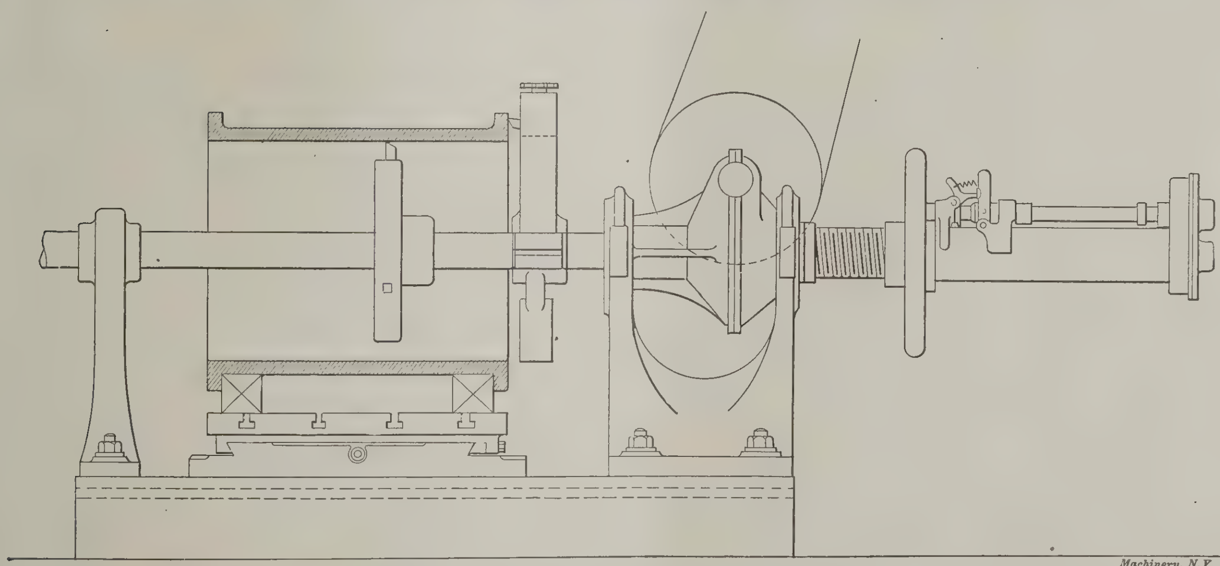


Fig. 12. Portable Boring Machine for Engine Cylinders.

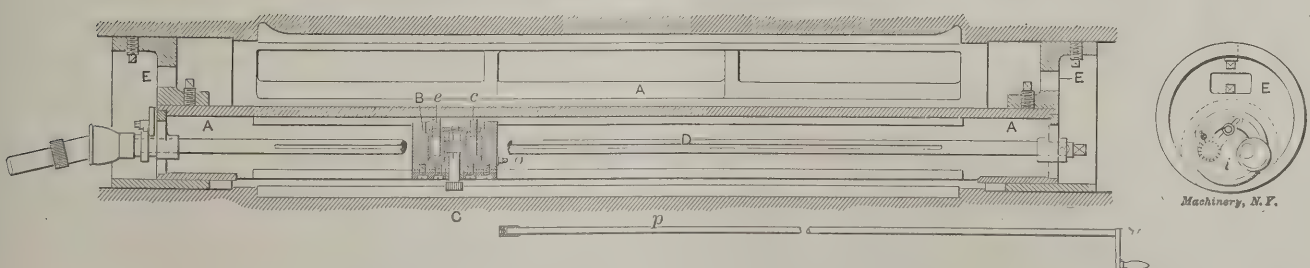


Fig. 14. Detail of Portable Tool for Milling Corliss Engine Cylinders.

great engineering schools, and ranks with the Massachusetts Institute of Technology in the excellence of its work. With this as the culminating point, the list, widening as it descends, embraces schools of various characters of the grade that Mr. Williston calls "technical schools," of which Pratt Institute and a few others are the only representatives in this country. Of these Switzerland has many; they prepare men for foremanships, positions as mechanical and architectural draftsmen, etc. Below this rank come the elementary technical schools and the trade schools. Some of these are of great size and

wide reputation, while others teach but a single trade and have perhaps only a single instructor, being located in the midst of the district employing the class of labor which the school is intended to furnish. One of those visited, a cabinet-maker's school, had only one instructor and twenty-five or thirty boys, but the artistic quality and finish of the work turned out, most of which was designed as well as executed by the students, was really marvelous. Institutions of this kind are almost unknown in this country; except for the small horological schools which are to be found in some of the watchmaking centers, we cannot call to mind an American parallel. Descending to the lowest grade, the elementary trade or industrial schools are found everywhere. Boys in the towns learn to use tools with the same facility that American children are taught to reckon interest on promissory notes, and this is done without sacrificing much of what we consider necessary to the boy's education.

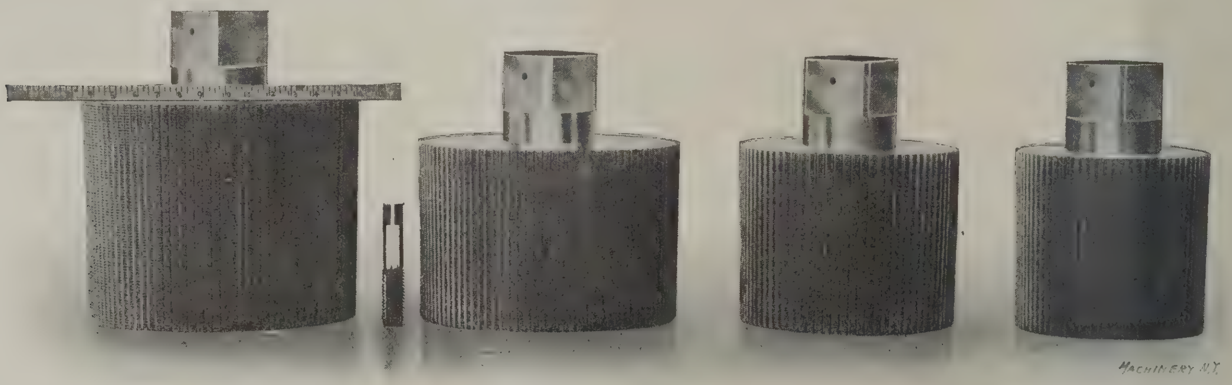
The still more highly developed German system of instruction provides for the "continuation school." When the boy is graduated from what corresponds to the grammer school he has two paths open. He may, if he possesses the inclination and the moderate means necessary, continue his education in the higher technical schools with the idea of becoming an engineer; or he may leave school and go to work in a factory, serving an apprenticeship in some trade. If he chooses the latter course, however, he is not by any means through with his education. He is required by law to attend this "continuation school' held evenings for six days in the week, usually, with five hours on Sunday. This lasts from two to four years longer. His time is largely taken up with subjects having some bearing on his business during the day, so it all makes toward his efficiency as a workman. The result of this completeness of education might possibly be somewhat disquieting to an American young man, arousing in him ambitions which there would be no opportunity to fulfill. Whether this would be so here, or not, in Germany with German workman it is fast bringing that country to the premier position in industrial competition. All the work which these engineers, draftsmen and mechanics are doing has to be done under any circumstances, and the question is, shall it be done by men who know merely the barest superficial rudiments of the business they are engaged in, or shall it be done by men intelligently educated, even over-educated, for the work they have to do. In Germany they have chosen the latter alternative and they seem to have chosen wisely.

* * *

LARGE HOB TAPS.

The accompanying halftone shows a series of taps which in all probability are the largest hob taps ever manufactured. These taps were recently made by the Pratt & Whitney Co., Hartford, Conn., and are to be used for oil well casings. The two largest taps in the series measure 12 and 12¾ inches in diameter, respectively. The threaded portion of the largest hob tap is 10 inches long, and has eight threads to the inch. This tap is provided with 104 flutes, the land and the flute being each about 3-16 inch wide, and if the tap were forced entirely through a piece of metal, it would thus present to the work more than 8,000 cutting edges. The total weight of this tap is 357 pounds. For comparison, a 1-inch hob tap is shown on the side of the largest tap.

The manufacturing of these taps presented, of course, no new principles, but that difficulties were encountered, particularly when hardening these large pieces of tool steel, is easily apprehended. The successful performance of the hardening operation is indicative of the efficiency of the methods employed in the manufacture of "small" tools on a large scale. In this connection it may be appropriate to mention that during the last few years the size of "small tools" has increased decidedly, and that many a time the name does not seem to suit the object. Inserted blade milling cutters, 30 inches in diameter and even larger, and gangs of interlocked cutters with 40 inches width of face are frequently encountered. The introduction of large size milling machines has made the requirements for a different type of milling cutters than those used only a few years ago imperative, and in almost all the branches of the small tool manufacture there is a tendency to increase the sizes of the tools used above the limits of former years.



Large Hob Taps.

THE ULTIMATE DEVELOPMENT OF THE AUTOMATIC MACHINE.

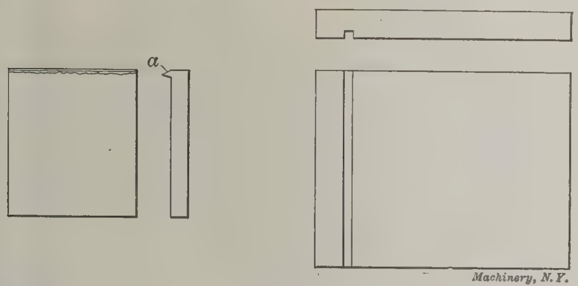
When describing a visit to a typewriter factory, a cotton mill, or any other place where automatic machinery is in evidence, the magazine writer always speaks of it as possessing "an intelligence almost human." What the possibilities are in the development of these machines toward the point where they will think for themselves, it is hard to say; even now they may be arranged to perform selective functions, guiding their action in accordance with the momentary condition of the materials they are working on. Many years ago Bulwer Lytton, in his book, "The Coming Race," suggested the possibility of the time when the problem of social inequality would be solved by the employment of automatons as servants, these mechanisms being guided by the telepathic communication to them of the desires of their masters. Perhaps this is an idle dream, but the writer lays claim to having discovered in an automatic machine an approach to one, at least, of the attributes of a human being—conscience. Each evening in returning home from the office he is confronted by a penny-in-the-slot chewing gum machine which has tempted him more than once to try the result of inserting a coin in the opening, with the hope of obtaining value received for what he has given up. He has been invariably disappointed in this experiment. The other evening as he stood glowering at the machine, soured by the memory of past misfortunes, his imagination could almost conceive that it was writhing under the withering scrutiny. Giving the plunger a vindictive jab, merely to express his feelings, without putting in the cent as on former occasions, what was his surprise to see the panic-stricken machine shoot a chocolate caramel out at him through the opening, and then—O, culmination of wonders! Two metallic tinkles, one after the other, announced the giving up of two of the numerous cent pieces which had been unavailingly surrendered to it from time to time. "Thus conscience doth make cowards of us all." May be the time is coming when this will apply to machines as well as to men.

DRILL JIGS.—1.

E. R. MARKHAM.

Drill jigs are used in drilling holes which must be accurately located, both in relation to each other and to certain working surfaces and points; the location of the holes is governed by holes in the jig through which the drill passes. The drill must fit the hole in the jig to insure accuracy of location. When the jig is to be used in drilling many holes, the steel around the holes is hardened to prevent wear. If extreme accuracy is essential, or the jig is to be used as a permanent equipment, bushings made of steel and hardened are used to guide the drills.

The design of a jig should depend altogether on the character of the work to be done, the number of pieces to be drilled, and the degree of accuracy necessary in order that pieces drilled may answer the purpose for which they are intended. When jigs are to be turned over and moved around on the drill press table they should be designed to insure ease and comfort to the operator when handling, and should be made as light as is consistent with the strength and stiffness necessary. Yet, we should never attempt to save a few ounces of iron, and thereby render the jig unfit for the purpose we intend to use it. The designer should see that the jig is planned so that work may be easily and quickly placed in and taken out, and that it can be easily and accurately located in order to prevent eventual mistakes. As it is necessary to fasten work in the jig in order that it may maintain its correct position, fastening devices are used; these should allow rapid manipulation, and yet hold the work securely to prevent a change of location. Yet, while it is necessary to hold

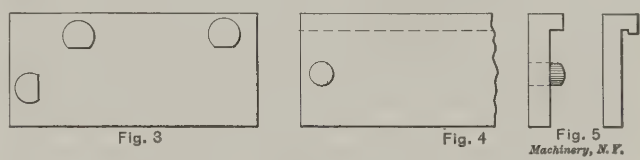


Figs. 1 and 2. Work with Burr and Grooved Part of Jig to correspond.

work securely, we should not use fastening devices which spring the work, or the holes will be not only improperly located, but they will not be true with our working surfaces or with each other. When finishing the surfaces of drill jigs and similar devices used in machine shops, the character of the finish depends entirely on the custom in the shop; for while in some shops it is customary to finish these tools very nicely, removing every scratch, and producing highly finished surfaces, in other shops it is not required, neither is it allowed, as it is considered a waste of time and an unnecessary item of cost.

When making drill jigs we must discriminate between measurements that must be *exact*, and those not requiring extreme accuracy; it is not generally allowed to spend the amount of time necessary to locate a hole within a limit of variation of 0.0001 inch or even closer, if a variation of 1-16 inch is insignificant. But if the holes must be located *exact* as to measurements, it is necessary to work as accurately as possible, and time cannot be considered a factor, provided a man improves every minute. Yet the fact that extreme accuracy must be observed does not warrant a jigmaker *wasting time*.

Before starting to work on tools of this character, the workman should first carefully look over his drawing, making himself thoroughly familiar with the construction, and making sure that the measurements given are correct; if in doubt about anything, consult the foreman, or the draftsman—according to the custom in the shop—in order that every detail may be thoroughly understood, or that any mistake made in the drawing may be rectified. A very poor policy is carried out in some shops. The drawing department and the shop seem to be at "loggerheads" with each other, and are constantly on the lookout for points on which to trip each other. This condition should not be allowed, as both departments are paid by the company to work for the interest of the firm, and not to hunt for chance to harm each other; and if best results are to be attained, there must be a correlation of departments, which condition cannot exist where there is jealousy or a desire to harm one another. The draftsman should always be ready to give any information wanted in the shop, and should also gladly correct any errors his attention is called to. I remember at one time a draftsman's attention being called to an apparent error in a drawing; instead of explaining matters to the toolmaker he informed him that his only concern lay in making the piece he was working on exactly as the drawing called for, and if it proved wrong it was none of his—the workman's—affairs; he was paid simply to follow instructions, and it was the business of the drawing room to give the necessary instructions. In making



Figs. 3, 4 and 5. Means for Locating Work in Jigs.

the drawing the draftsman had, in order to save time, shown several screws as being without threads; they were made of the proper size and length, with slotted heads, yet without threads, the draftsman knowing that the toolmaker would know what was wanted. The latter, however, was offended, and in order to get square for his recent snub he made the "screws" as represented on the drawing, fitted them to the holes and drove them home. When it was discovered, and he was questioned about it, he told what the draftsman had said to him, and said he had followed his instructions implicitly. I need not tell you that he was discharged, and think every fair-minded man will agree that he should have been; but I think the draftsman should have been made to go with him for creating a feeling of antagonism rather than of good will toward himself. Many times one draftsman is puzzled to understand a drawing made by an equally good man, especially so if the work is foreign to him; and a shop man who may not be very well versed in reading drawings—yet be an excellent workman—may easily get puzzled when he attempts to read a drawing of work he is not familiar with.

While the above does not relate to toolmaking in the strict sense of the term, yet it seems advisable to speak of it, as the condition is altogether too common.

It is necessary when designing tools of any character, whether they be cutting tools or fixtures for holding work while machined, to make provision for the chips. These are

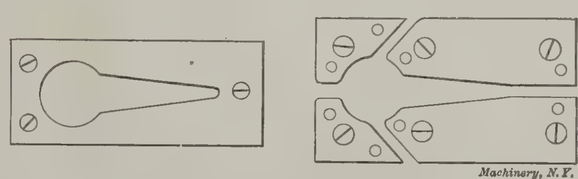


Fig. 6. Method of Locating Work in Jigs.

liable to get into drill jigs, and despite ordinary care get under the work or between it and the locating points. In order to do away, so far as possible, with this tendency, it is advisable to cut away as much of the seating surface as can be spared, and to locate stops away from the seating surface if possible. The seating surface should be smooth enough so that chips will not adhere to it, and so that waste will not stick to it, but it should not be a polished surface, as we would in all probability get it out of true if we attempted to polish it. If chips are allowed to get under the work it will not be drilled true; that is, the holes will not be at the proper angle with the working surface, and consequently the piece will be unfit for most purposes.

Many operations of machining are almost sure to throw a burr on one side of the piece, and in shops where quantities of work of the same kind are machined, men or boys are kept

busy removing these burrs in order that they may not interfere with the proper seating of the pieces during the succeeding operations. While the operation of removing the burr on a single piece of work may not incur great cost, yet when thousands of pieces are machined each day, the aggregate cost constitutes quite an item of expense, and the successful manager is he who so far as possible eliminates the small items of expense, knowing that many small items of expense amount to a large item in the aggregate. Not only is the operation of burring expensive, but as the class of help usually employed to do this work is unskilled, surfaces are many times left in a condition anything but satisfactory. As a consequence, the surfaces of jigs, milling machine fixtures, etc., are many times cut away to receive these burrs, thus doing away with the necessity of burring, and it many times happens that subsequent operations remove the burrs. In Fig. 1 is shown a piece of work having a burr thrown out at *a*, while Fig. 2 represents a surface cut away to receive the burr.

When we wish to drill two holes a given distance apart, the location of the holes is obtained by means of a pair of dividers set to a scale. The location is obtained and prick punched, after which the holes are drilled. This method answers nicely when one piece is to be drilled, and precise measurements need not be observed. If it is necessary to drill ten thousand pieces, then this becomes a costly method and the work can be done more cheaply if a jig is made to hold the pieces. The jig must, of course, have holes the size of the drill, which are properly located. By the use of the jig the cost of drilling is but a fraction of what it would be if the holes were located by dividers, and the surface prick punched as described.

A factor which must be considered is the cost of the jig. If the cost of the jig plus the cost of drilling would exceed the cost if the pieces were first prick punched and drilled as formerly described, then the making of the jig would not be considered unless a greater degree of accuracy was necessary than would be liable to be the result of the method mentioned. When a jig is to become a permanent part of the equipment of a shop, its first cost is not so much a matter of consideration as when only a limited number of pieces are to be drilled. Yet no unnecessary expense should ever be allowed.

Many times when only two pieces are to be drilled which must be exactly alike as regards location of holes, it is cheaper to make a simple jig than to attempt to drill them by any of the methods commonly used in machine shops. In such a case the jig may be made from a piece of cast iron or other material which may happen to be on hand, the holes being carefully laid off and drilled. This jig makes it possible to drill the holes in both pieces exactly alike as to location. When using a jig of this description it is possible to locate the holes near enough for most work by ordinary measurement. If many pieces were to be drilled, it would be necessary to provide locating points so that the pieces could be placed in the jig, and the essential surfaces brought against these. The means of locating may be pins, as shown in Fig. 3, or a shoulder and a pin, as in Fig. 4. If pins are used, they should be so located that the bearing surfaces may be worked flat, as shown, to prevent wear, and also to do away with a tendency to press into the surfaces of the work. If flat shoulders are used they should be cut away, as shown in Fig. 5, to do away so far as possible with a liability of dirt or chips getting between them and the work. Then, again, if the working edges of the pieces of work are not exactly true, it would be impossible to properly locate by pressing them against true locating surfaces which extend the whole length.

When work is of irregular contour that could not be properly located by bringing it against two locating surfaces it is possible to provide a locating device which bears against all the surfaces, as shown in Fig. 6. This method, however, is hardly to be advocated for most work, as it necessitates exactness of measurement and shape on all the bearing surfaces. Then, again, the shape makes it extremely difficult to clean, and a chip under any portion of the work will cause it to stand at an angle with the seating surface of the jig.

THE EXPERIENCE OF BEAUREGARD NAPOLEON FREDERICKSON WITH THE PROFIT-SHARING SYSTEM.

"THE HIRED MAN."

Beauregard Napoleon Frederickson called by his host of friends "Gardie Fredericks" in loving abbreviation, was, and is, one of the best fellows that ever laced a belt; this does not mean that he spent the money that should have been spent for his wife and babies in "setting them up" in bar rooms for his host of friends, nor on the other hand does it mean that he was afflicted with "the deadly dullness of the merely virtuous."

Gardie was a good mechanic, and alas! an inventor also; all of which wouldn't have been so bad, but he was, in addition to all these things, a sucker. How could he be a good fellow and a sucker, too? Why, bless your heart, I don't mean a sucker from a shop standpoint, but one of the kind that some classical writer has assured us is born every minute. So, being an inventor, he brought forth his celebrated "whirlwind whirligig" with a sort of "dusky diamond attachment," and having been born at the psychological moment aforesaid, it wasn't long before he was soon collared by Charlemont Worsley Hornswoggler, who, having been born at a

"* * * * all the profits made on the selling end of the business * * * * unable to figure any profit at all for the factory."

different minute from the subject of our sketch, could not only see through a hole in a ladder, but knew a good whirligig when he saw it. The result was that Mr. Beauregard Napoleon Frederickson assigned all his right, title, etc., in the whirligig to Mr. Charlemont Worsley Hornswoggler and to his heirs and assigns forever; in return for which Hornswoggler was to furnish a factory and machinery and other capital necessary to manufacture the whirligig, and give B. N. Frederickson a stated salary for running the factory and a share of the profits. (As Artemus Ward would say: "The printer must put some stars here.") * * * *

What is the use of going on? We have now reached what corresponds to the end of the third act of a play in a theater, and everybody can see how the last act will end. But as people usually stay to see the last act, and as the editor will probably refuse to give me the large check he has bribed me with to get this story, unless the story is finished, here it goes! When the things got to moving in good shape, and it seemed there ought to be a pretty good sized wad to spare, our hero borrowed a plug hat and went over to the city office to look it up. Mr. Hornswoggler told him that he had carefully figured the thing out, and found that, while there had been considerable money made, it had all been made on the *selling end* of the business, and that he had been *unable to figure any profit at all for the factory.*

THE VALUE OF "NON-PRODUCERS" IN MANUFACTURING PLANTS.

H. K. HATHAWAY.

The greatest fallacy that exists to-day in the minds of most proprietors and managers of manufacturing plants is the idea that if they keep down the proportion of so-called "non-producers" they are necessarily saving money; but in considering the subject of non-productive expense, they are so alarmed by the thought of spending money from which they can see no immediate tangible return, that they do not look beyond the surface; and thus they deceive themselves in the belief that they are acting wisely in curtailing the number of "non-producers," whereas, if the subject were thoroughly investigated, the opposite course would often prove the one to be followed. The object of this article is to represent the matter in its true light, and to show that mere "non-producers," if their efforts are properly directed and utilized, are in most cases, not only profitable but essential to economical production.

The term "non-producer" is generally applied to clerks, foremen, inspectors, helpers, and others, whose labor is not directly expended in transforming raw material into product to be sold; while those whose labor is so expended are classed as "producers."

A few years ago the writer was superintendent of a plant whose principal product was automatic steam engines; this concern employed about one hundred and twenty-five men, and had started in a small way about fifty years ago. It prospered and grew for about forty years, and then, for no apparent reason, began to slowly retrograde until finally it failed completely. To the end the product was of the same high standard of workmanship and design that had contributed to the early prosperity of the plant, having been improved from year to year to keep pace with the demand for something better, and to compare favorably with the goods put on the market by competitors. The business policy was unchanged, and the same methods of manufacture and management that had prevailed in the period of prosperity were still adhered to.

In this plant there was only one foreman, who kept track of all the work in progress, looked after the quality of the work, the discipline, and all other details connected with the operation of the plant. Each workman ground his own tools, and had them dressed when necessary; repaired his own belts, and took care of the appliances used by him. Only two or three laborers or helpers were required, as the men helped each other in getting work to and in and out of their machines; and only one clerk, besides the bookkeeper, was necessary to keep the men's time and make up the pay-roll. Thus the number of employees classed as non-producers was remarkably small; the manager saw to that, and impressed upon the writer the stern necessity for keeping it down, and reducing it further if possible. The item of "non-productive" expense was so carefully watched and guarded against that the workmens' daily time cards showed that almost the entire time of every man was spent on productive work.

This, however, while apparently representing a very desirable state of affairs, was not indicative of the true conditions, which were something quite different, as will be shown by a more thorough analysis. In reality, only about 50 per cent, or less, of the time was spent in actually producing, the balance being consumed in preparing to do the work, that is, in doing things that should have been done in advance by "non-producers," the rate of pay of most of whom would have been less than that paid to the "producer." To illustrate this point, we will consider that the workman has just finished a job. He then hunts up the foreman to learn what he is to do next; the foreman, after considering, tells him, and the workman finds the job and moves it to his machine. He then goes after the drawing, which may be anywhere in the shop, after which, unless he is perfectly familiar with the job from having done it before, he will again hunt up the foreman for some explanation of what is to be done. The next thing is to set the job in the machine. His clamps are often missing or not suitable, his bolts are not the right length and have no nuts or washers on them, or the threads are in such bad condition that the nuts have to be forced on with a wrench. The writer has seen cases where men have spent as much time looking for a bolt or a clamp with which to hold a job as was required to do the work. After the job has been set the workman looks up his tools, which have to be ground; so he takes his place at the grindstone, which is usually worn out of shape, and waits his turn with the two or three others who are always there.

He has now completed his preparations. The time consumed in making them is charged to the job and considered as productive labor, although in this time neither the man nor the machine have produced anything. All of these preparations, except the actual setting of the job, could have been made by "non-producers" before the workman had finished his preceding job, and the machine could have been producing continuously. The state of affairs here outlined is one which exists, in a greater or less degree, in almost every shop, the management being blinded to it through having its attention taken up by matters of seemingly greater importance, or regarding it as an unfortunate condition of affairs for which it can see no help.

After the writer was thrown out of employment by the failure of the concern referred to, he had the good fortune to become connected with another plant, of about the same size and producing a line of work not differing essentially from that of the first one. This concern had been run for years upon much the same lines as were followed by the firm that failed, but the management had realized in time the necessity for taking some action to avert a similar fate, which had begun to cast its shadow before it; so with this object in view they had started to install the "Taylor System of Works Management."

During the past year the output of this plant has increased more than 100 per cent, with no increase in the pay-roll; and the most interesting thing about it is that, in effecting this result, it was necessary to increase the "non-productive" force from a total of six or eight men to twenty-five men, and to make a corresponding reduction in the number of so-called "producers." In this plant the "Taylor System" provides for having all the preparations made in advance for the workmen; and it is in carrying out the system that the "non-producers" referred to are employed. The nature of their work is outlined in the ensuing paragraphs.

When it is decided to manufacture certain machines or parts, either to fill specific orders for customers or for goods to be carried in stock, a manufacturing order is issued, which passes in turn through the hands of a number of clerks in the "planning department," whose duty it is to plan and arrange for furnishing the tools, materials and appliances to be used in manufacturing the articles called for on the order, and prescribe the methods to be followed in doing the work in the quickest possible time, and in a manner to meet the requirements as to quality.

The first of these "non-producers," called the route clerk, must be a man with practical shop experience, and it is his duty to determine what operations must be performed on each part, and to prepare the route sheets, which indicate these operations and show in what machines they are to be done. He must specify how much of each material is required, specify the number of castings, and must furnish the necessary orders on the storekeeper for the materials. If the articles called for on the manufacturing order consist of a number of parts to be assembled, as in the case of complete machines, the route clerk must plan out the method to be followed in assembling, and so arrange the parts into groups or divisions as to enable the assembling to be done with the least delay; certain groups are thus assembled while the parts for others are still being machined. He must prepare a chart, or working diagram, showing this arrangement of the parts, and giving detailed instructions for the guidance of the assemblers.

The relation of the parts to each other is kept in mind in getting the castings into the shop and in doing the machine work, so as to insure that all the parts of each group shall be delivered to the assemblers as nearly simultaneously as possible. For example, in building a steam engine, if the cylinder, flywheel, and connecting-rod boxes arrived on the assembling floor together, it is obvious that nothing could be done toward erecting the engine; whereas, if the cylinder,

piston, cylinder heads, valve, and steam chest cover arrive together, it is possible to proceed with the work at once.

The manufacturing order next goes to a clerk, who keeps a running balance of all raw and worked materials carried in stock, and subtracts the materials called for from the quantities shown to be available. This clerk is also responsible for issuing orders for replenishing stock, as soon as the quantity available falls to a certain minimum. The foundry clerk orders any castings required that are not regularly carried in stock, specifying the dates on which they must be delivered, and following them up regularly by means of a "tickler."

Instruction cards are next prepared for each operation on each part, giving in detail the method to be followed in setting the job, the tools to be used, the feeds, speeds, and cuts to be used, and the time allowed to do the work. The clerks who make up these instructions must be practical shop men, possessing considerable experience and good judgment. The time allowed for a job is based on "elementary time study," such as Mr. Taylor has described in his papers on works management. Barth's slide rules are used in setting the feeds and speeds at the proper figures. The various orders for performing the operations, for moving the work to another machine after the completion of an operation, for inspecting the work as required, etc., are then written, and the work is begun on the order in the shop.

There are, in the planning department, in addition to the clerks mentioned, the timekeeper, cost clerk, and several messengers, and besides these, the production clerk, the order of work clerk, and the recording clerk. The production clerk sees that orders go through the planning department without delay, and watches the progress of the work through the shop to see that goods are finished and ready for shipment when due. The order of work clerk plans ahead the work to be done by each workman, and arranges the order of work ready to be done by each machine, in accordance with the "Order of Work" or schedule given him by the production clerk; he sees, also, that plenty of work is kept ahead of each workman. The recording clerk enters on the route sheets the progress of the work as it moves through the shop.

In the shop where there was formerly but one foreman there are now several, each of whom has a certain function to look after. The gang boss has charge of the work when the machines are not cutting, and it is his duty to look after the setting up of the work, and the preparations for doing it in accordance with the instruction card. The speed boss has charge of the work while it is being actually machined, and sees that the tools, feeds, speeds, and depth of cuts used, are as specified on the instruction card, and that the workman operates his machine to the best advantage. The inspector is solely concerned with the quality of the work, and it is his duty to see that the work done is up to the required standard of finish and accuracy. The repair boss looks after the repairs and maintenance of the machines, shafting, and belts.

The moving of materials is done by special laborers, and is controlled by the recording clerk in the planning department, nothing being moved except upon a written order issued by him. After a job has been moved to a machine where an operation is to be done on it, the order of work clerk issues the order for doing that operation, and the drawing and the instruction card are delivered to the workman. All tools required to do the work are brought in a "tote box" to the machine by a messenger, tools and appliances of all kinds being kept in the tool room in constant readiness for use. The gang bosses are required to see that these preparations are at all times made for at least three jobs ahead for each workman.

When a workman starts a job, an order is at once sent to the inspector, notifying him to that effect, and requiring him to immediately see that the workman thoroughly understands what is required, and to inspect the first piece finished. This inspection at the start of a job is for the purpose of preventing mistakes being repeated on the entire lot of parts, and is most effective in reducing bad work to a minimum. Upon completion of the entire lot of parts, they are again finally inspected, before being moved to the machine that is to perform the next operation.

With the work thus planned and prepared for in advance, and with the various "functional foremen" not only directing the men, but assisting them to perform a definite task in a definite time, it has been demonstrated that each workman, by actually doing productive work all of the time, can turn out from one to three hundred per cent more work than he is able to do in a shop run as many are, where the planning and preparations are left to be looked after by the one "overworked foreman" and the workman, no matter how competent either of them may be.

In concluding, the writer wishes to call attention to the fact that the "non-producers" in the planning department and in the shop are doing nothing but what had to be done by somebody under the old form of management, with the difference that, under the "Taylor System," each thing is done in a systematic manner by men qualified by training in that particular thing, whereas formerly it was done much less efficiently in the shop, and charged against the job as productive work. The fact that it is being done by a man who should have been producing, but whose machine was standing idle, does not make it productive labor. It does not matter whether the wages for "non-productive" labor are 10 per cent of the total pay-roll or 60 per cent of the total pay-roll, the only sound basis of judgment being a comparison of goods produced per dollar expended. On this basis it has been clearly shown, as in the case of the second plant described, that it is a mistake to fight shy of "non-producers," provided, as before stated, that their efforts are properly directed and utilized. The proportion of "non-producers" required to obtain the best results, depends upon the nature of the product and the quantities handled.

* * *

THE GROWTH OF THE CEMENT INDUSTRY.

The Portland cement industry in this country presents one of the most marvelous instances of growth on record. The use of cement for all forms of construction—for railroad, dock and harbor work, great office buildings, factories, hotels, dwellings, and a thousand and one other things—has occasioned the amazing increase in the output in the United States from 42,000 barrels in 1880, to 35,000,000 barrels in 1905, or over 800 times as much; whereas in pig-iron production the output in 1905 was only about six times that of 1880. This marvelous growth of the cement industry, however, has in no way interfered with the growth of the iron industry. To the contrary, cement has come as an auxiliary to help maintain the vast building activity, preventing an iron and steel famine, which would have upset all building operations throughout the country. As concrete has supplemented iron so has it helped the lumber situation through its use in many forms of construction where timber would otherwise have been essential. The scarcity of timber is growing to an alarming extent. Experts have placed the limit of supply at 35 years. The advent of the cement industry is therefore important in helping to save the American forests from complete destruction. The manufacture of all this cement requires a vast amount of machinery. Many plants have sprung up within the last few years in various parts of this country, whose capacities run up into thousands of barrels daily. Contracts for cement-making machinery calling for an expenditure of hundreds of thousands of dollars are of frequent occurrence to the large cement machinery manufacturers. What is said to constitute the largest individual order ever placed for tube mills for the grinding of cement clinker is one recently placed by the United States Steel Corporation. This order calls for forty-seven tube mills, 5 feet in diameter by 22 feet in length. Twenty of these are to be installed in the plant of the Carnegie Steel Company at Homestead, Pa., and twenty-seven are for an extension to the immense modern cement plant of the Illinois Steel Company at Buffington, Ind. This entire order was awarded to the Power and Mining Machinery Company, Cudahy, Wis.

* * *

The production of gold which has of late commanded so much attention, is still continuing to increase. August returns from the Rand mines in South Africa show that the output is nearly 20 per cent in excess of the output during August last year.

COUNTERBORES WITH INTERCHANGEABLE BODIES AND GUIDES.

ERIK OBERG.

The efforts constantly made by progressive manufacturers to decrease the cost of tools without impairing their efficiency have resulted in the design of a number of holders for cutting tools which permit a cheaper grade of material to be used in the holder proper, while the best quality steel can be used for the cutting tool itself. A further impetus to these efforts has been given by the extensive use of high-speed steel, the price of which is so high as to make its use for many purposes prohibitive, if the whole tool should be manufactured throughout of this material. Many tools which only a few years ago were almost invariably made solid are therefore to-day made up in several parts, the portion which performs the cutting being the only one made out of high grade material. Incidentally another advantage is also gained. Inasmuch as the cutting portion of a tool is the only one which, in general, when worn, has caused the tool to be discarded, it is now possible to retain all the other parts and replace the cutting portion only.

The accompanying cuts show a number of counterbores with interchangeable bodies and guides. In the case of counterbores the interchangeability is even of a greater advantage than in many other tools, inasmuch as here a number of guides can be used with the same body, and *vice versa*, thus making it possible to replace a very large collection of solid counterbores with a single holder and a few bodies and guides.

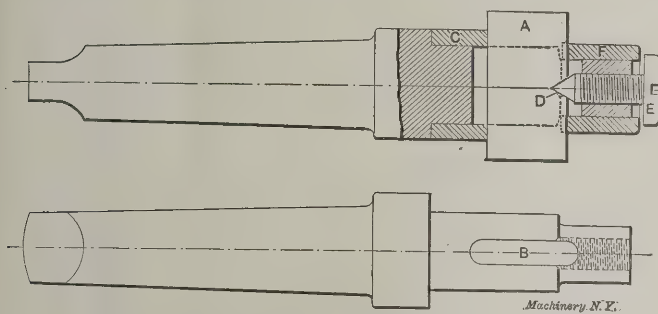


Fig. 1. Counterbore with Interchangeable Blade and Guide.

Fig. 1 shows a counterbore where the body consists simply of a blade *A*, inserted in a slot *B* in the holder. The blade rests upon a hardened tool steel collar *C*, which is driven in place. A slot is milled across the blade in the center at *D*, and a setscrew *E* serves the double purpose of binding the blade against the collar *C* and holding it central. The guide bushing *F* is provided with a small slot fitting over the blade to prevent it from turning, and is kept in place by the head of the screw *E*. There is, however, a slight allowance for play between the guide bushing and the head of the screw, in order to insure that the screw will bind the blade in the slot *D*, and not tighten down upon the bushing before binding the blade. By simply removing the screw the counterbore can be provided with any size blade and guide within certain limits. This class of counterbores is manufactured by the Pratt & Whitney Co.

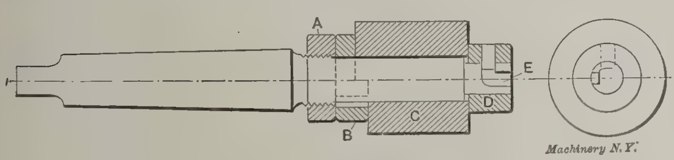


Fig. 2. Counterbore with Interchangeable Body and Guide.

Fig. 2 shows a counterbore of a different type. The collar *B* is keyed to the holder, and is provided with a step as shown in the cut by means of which the counterbore-body *C* is driven. The collar is movable in the longitudinal direction of the holder, being pressed down toward the counterbore by means of the nut *A*. The thrust when binding is taken by the guide bushing *D*, which is provided with a pin sliding in a slot in the guide pin *E*. This slot is milled in the longitudinal direction of the holder about one-half of the length of the guide pin, and is then milled in form of a circular groove about one quarter of a revolution. When the guide bushing with its pin is pushed over the guide pin and given a quarter of a turn, the nut *A* can be screwed down until it holds the body of the counterbore firmly in place. The advantage of this type is that the bushing and body can be very quickly changed and are simple to duplicate.

Fig. 3 shows a counterbore of a somewhat similar type. Here the driving collar *A* is fastened to the holder by a taper pin, and provided with a key freely fitting a slot in the body *B*. The guide *C* is screwed into the holder, and binds the counterbore-body against the driving collar. The guide is provided with a screw slot to facilitate its being screwed in and out. A portion, *D*, on the stem of the guide should be plain and a good fit in a plain hole in the holder, in order to insure that the guide will be concentric with the body of the counterbore. The thread must, of course, in such a case fit very freely.

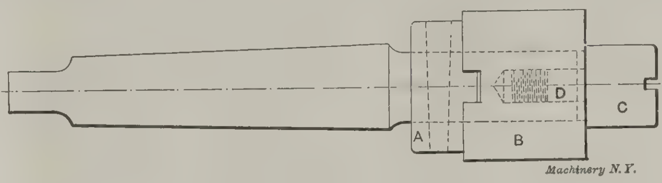


Fig. 3. Counterbore with Interchangeable Body and Guide.

The variations possible are evidently many, but the types represented involve the principles upon which interchangeable body and guide counterbores are designed. The body and the guide should be easy to duplicate, there should be means insuring that they will always remain concentric in relation to one another, and all details, needing fitting when made, should be contained in the holder itself in order to prevent difficulties arising when placing new bodies or guides on old holders.

* * *

There is a large class of persons totally unfamiliar with machine shop operations and who have but the vaguest ideas of the methods and machines employed for reducing forgings and castings to shape required for machine construction. A not uncommon idea of the tyro is that a faced part is done at say one sweep of a broad-face tool, and that cylindrical parts are turned in the same manner. *We*, of course, know that in the beginning the fundamental design of all machine tools was based on the holding of a narrow point tool and feeding it progressively as the work rotated or reciprocated. In this way a small portion of metal is attacked at once and successive furrows are made the same as in plowing a field. The width of the plow furrow is limited to the strength and endurance of the team, and the depth and width of a lathe cut is dependent on the rigidity and power of the machine. In time, as the design of machine tools increased in power and rigidity, the width of the cut was increased; the forming idea became more pronounced and the use of broad-faced tools which would actually sweep at one revolution a complete cylinder of definite length was an established fact. To-day this idea has been carried to an extent which would astonish those who are familiar only with the earlier types of machine tools. For example, a special machine has been built by one well-known concern for facing a certain part in three different places at one operation. Each of these three operations would have required at least twenty minutes if done in an ordinary 24-inch engine lathe of a generation ago. To-day, this special machine, which weighs as much, perhaps, as ten engine lathes, does the three operations in one-twentieth of the time. It literally "hogs" the metal off at say, two or three revolutions, followed with a finishing revolution, and the work is done. It seems hard to conceive of the development of machine tools being carried to a much greater extent than this. Any further improvements would mean the elimination of machining, and perhaps this in time may come when the molder succeeds in producing molds mechanically perfect and which are not destroyed for each casting. This, already done with alloy castings, does not, however, promise much for the more refractory metals like iron, steel and brass. Shrinkage must first be overcome, and this is a large job alone.

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RAILWAY MACHINERY

A SPECIAL EDITION OF MACHINERY FOR THE RAILWAY SHOP, DEVOTED TO LOCOMOTIVE AND CAR EQUIPMENT AND MECHANICS.

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We solicit communications from practical men on subjects pertaining to railway machine shop practice, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

NOVEMBER, 1906.

The Walschaerts valve gear of which we made mention in our October issue has again been discussed at a convention of railroad men, this time at the fourteenth annual convention of the Traveling Engineers' Association. A paper was read before the convention by Mr. O. H. Rehmeyer on the Walschaerts valve gear in which he briefly refers to the history of this type of gear and to its adoption for American locomotives, comparing some of its features with those of the Stephenson link motion. It was pointed out that the Walschaerts gear is superior from the standpoint of inspection on account of all parts liable to defect being in plain view and easily examined from the outside. In regard to the cost of maintenance of this gear compared with the Stephenson valve gear, the author believed it to be fully 25 per cent less and expressed the opinion that the Walschaerts gear will handle a train better at a slow rate of speed with very little slipping, while with the Stephenson motion there is a greater tendency to slip at slow speed, requiring a greater amount of sand to prevent it. The ensuing discussion evinced the Walschaerts valve gear to be in general favor, especially so in view of advantages gained by placing the motion on the outside and removing difficulties consequent upon the motion work of heavy engines being between the frames, and the Walschaerts gear was reported to be popular among engineers.

* * *

RAILWAY ACCIDENTS.

The frequency of serious accidents on American railways has made the general public so accustomed to these occurences as to class them amongst those which are nearly inevitable. It must be deeply regretted that such a condition should exist, because frequent railway accidents are by no means necessary, if proper regard is paid to the safety of passengers. The conditions on European railroads, where accidents are incomparably fewer than on American roads, vouch for this statement. Nor is it possible to argue that traffic on American roads is so much heavier, or speeds so much greater than on European roads, so as to make the chances for accidents more frequent. The traffic and the speed maintained on any of the great European thoroughfares compare with the traffic and the speed of our own railroads. It is difficult to give a valid reason why such an unfavorable condition should exist here, if it has been possible to eliminate accidents to a great extent elsewhere. For the sake of comparison with European experiences it is interesting as well as instructive to note that on the Swedish state railways, which at present carry more than 11,000,000 passengers a year, the total loss of life of passengers during the last forty years has been only eight. The number of passengers injured in railway accidents during the same period has been fifteen. While we do not have any record of the casualties of any American system carrying approximately the same number of passengers a year, it is too well known a fact that we could not find any record that would compare favorably in the slightest degree. It is time that there be a general demand for greater safety on our railroads, and the country as a whole will have taken a step forward in a direction which we have partly ignored during our general progress.

* * *

REGULATION OF INTERSTATE COMMERCE.

"Congress shall have power to regulate commerce with foreign nations and among the several States, and with the Indian tribes." Article 1, Section VIII.

The Constitution of the United States is justly regarded as a most remarkable document; the vision of its founders seems to have been prophetic, as it is adequate for conditions that otherwise could scarcely have been provided for at the time it was written. This applies with especial force to the part quoted and few of us at the present time realize the importance of this paragraph, or what developments will come from its liberal interpretation. Seemingly some of the mightiest movements of the present era will pivot on this interstate commerce clause. Not only is it to be used to compel equitable freight and passenger rates, but the regulation of railways in functions which have heretofore been regarded as strictly those of private corporations; it will be the lever by which the packing of pure food products will be assured to the people, and the manufacture of any product going beyond the bounds of the State may be regarded as coming under the scope of government authority because of this fortunate Constitutional provision. But stranger still is that it may be made a powerful lever for controlling and regulating swollen private fortunes, a menace which to-day looms with frowning front. Few indeed of the great fortunes which have been accumulated are restricted in the scope of their activities to one State. The moment they go out of the State they become subject to the interstate commerce law of the Constitution and hence are susceptible to government regulation. It appears that a liberal interpretation of this clause will be a much more effective lever for public weal than any government ownership scheme could possibly be.

* * *

CAR CLEANING.

The subject for discussion before the New York Railroad Club at the October 19 meeting was a paper on car cleaning read by Mr. B. P. Flory, mechanical engineer of the Central R. R. of New Jersey. It was descriptive of the vacuum system of car cleaning in use at the Jersey City terminal of this road. It is a somewhat curious fact that up to within a few years the improved method in general use for cleaning cars was the so-called pneumatic system, using compressed air for blowing the dust out of the cushions, carpets, etc. While the advantages of the "sucking" or vacuum system were obvious, no one seemed to have the courage to try it, chiefly on account of the difficulty of getting rid of the debris so that it could not be carried over into the vacuum pumps, etc. The compressed air system has the great disadvantage of merely displacing the dust, and if cleaning is carried on within a car the dirt simply changes position and settles on the other interior parts of the car. The advantage of the vacuum system is that the material is not only displaced, but is carried away through a hose and disposed of without any annoyance. It is not very much more rapid in operation, but obviously much more hygienic, all germs being whisked away where they can no longer be a source of trouble. Mr. Flory said that the plant installed at the Jersey City terminal for cleaning the cars and station has been in operation now about two years and the first cost was about $18,000. This includes the cost of two double-acting steam pumps of 20 H.P. each and a pipe system with distributing outlets in the coach cleaning yards, etc. A vacuum measured by about 14 inches of mercury is the usual working force. His conclusions are that the vacuum system is more economical of power; the cost for labor is reduced; all dust is absolutely removed from the seats, back, and carpets; the varnish is not injured by having particles of dust or cinders blown against it, it keeps the equipment in better shape; and the cars can be cleaned quicker and turned in less time than with compressed air.

AUTOMOBILE FINE SCREW THREADS.

We give publicity to the newly adopted thread standard of the Association of Licensed Automobile Manufacturers, the details of the standard forming the subject matter of the article on page 148 and of the current supplement. It will be noticed that the pitch of the threads of the various screw diameters is considerably finer than that of the Navy, United States or Sellers standard, as it is variably called. For example, the pitch for a ¾-inch screw is 16 threads per inch instead of 10, and about the same proportion holds with all the screws from ¼ inch to 1 inch diameter, inclusive; the number of threads per inch being increased by about 50 per cent on the average.

The needs of the automobile, especially that of the racing type, undoubtedly require a finer pitch screw than the present American screw standard. This feature is one thing that has made for the superiority of the foreign machines, their builders having generally used screws much finer than our standard pitches and thus much less likely to be jarred loose. The Association of Licensed Automobile Manufacturers recognized the condition and adopted the present standard which, in itself, is commendable but somewhat hasty. In giving publicity to it, we do not indorse it, except that we also recognize the need for the finer pitches, not only on automobile construction but certain other machinery as well. We believe it is unfortunate that this move should have been made without a more common indorsement which would have given it a better standing and have paved the way for its general adoption as another standard alongside of the present United States standard. The adoption of a new standard of screws should only have been made after careful consideration and consultation with men whose opinions have weight. How much of this was done we do not know, but it comes as a surprise to most people outside of the automobile business.

It might be said that we had just arrived at the stage of having standard screw threads. The general adoption of United States standard thread brought order out of chaos and was perhaps one of the greatest moves for advancement in machine construction ever made, as it tended toward interchangeability. Now, if the manufacturers of special products, such as automobiles, etc., are to feel free to adopt new standards which seem to them better suited to their peculiar requirements, it will be only a question of a few years when we shall again in a measure be in the confused state as regards screw threads that marked manufacturing before the present era.

The United States standard screw threads are admirably adapted to the needs of heavy work, such as bridges, buildings, cars, locomotives, etc., being easily manufactured and not readily bruised and damaged by rough handling. The needs of the automobile, of course, are quite different. Not only are the parts relatively smaller, but, being made of finer material, much stronger. Better workmanship permits the use of finer screw pitches, and the extreme vibration incident to high speeds undoubtedly requires a system different from that of the United States standard. While some agitation has already been made toward the adoption of a finer system of threads it has not materialized into anything definite. Perhaps this radical departure will bring matters to a focus and result in giving us an authoritative standard of finer pitches adapted to special machinery, either as an indorsement of the one in discussion or of some other—it does not matter particularly so long as it meets the wants and is generally recognized. It is to be hoped that something of this nature will be the result.

* * *

A GROWING OPPORTUNITY.

When the young man is casting about for a profitable and congenial business to which to devote himself for life, if his inclinations lead him toward the realm of engineering, he cannot but feel somewhat disheartened by the state of this profession at the present time. There are scores of engineering schools in the country attended by thousands of students, great numbers of whom are graduated each year. It is truly said that there is a great demand for these graduates on the part of engineering firms in various lines, but this demand is for young men who are willing to work for long hours at small wages for the sake of gaining "practical experience." The upward steps from these positions are difficult and the openings leading to the ascent are few. Besides, the salaries obtained by even the best engineers are not commensurate, so at least it seems to the young man, with the time and study and money which he has expended on his education. Especially is this so when compared with the harvest reaped by the financial managers and the members of the selling organization in great industrial undertakings. The expert in salesmanship, the man who obtains the big contracts and brings in business, is the one who up to this time has been the most valued member of the salaried organization.

It is not safe, however, to consider this as a permanent condition. While this field is an attractive one at present, the increasing growth of the idea of combination and community of interest is bound to lessen competition more and more as time goes on, and competition is the only factor which makes it possible for the selling agent to receive the abnormal rewards which he now enjoys. Considered from a purely abstract standpoint, indeed, this condition does not seem to be a stable one. The salesman's business is an economic waste, so far as the country at large is concerned, in the sense that he does not add to the wealth of the country an amount corresponding to the value he receives for closing his large contracts. He merely diverts business from one channel to another. The consumer is therefore compelled to pay something more than the intrinsic value of his purchase for the privilege of having his order subjected to the fierce rivalry which has hitherto characterized the industrial world.

With the partial decadence, at least, of the importance of the selling end of the business, more and more will appear the necessity for reducing the cost of production to the lowest possible point. Competition in the future will largely be waged in the work shop and factory instead of in the city offices of manufacturing firms. This condition is one that must, in the nature of things, call increasingly for men skilled in the art of production at a minimum cost, who can get the most possible out of men and machines without unduly distressing either. This is the most attractive opening for the intelligent, energetic young man of to-day. The steps that he should take to perfect himself in the art of management cannot be definitely laid down. Each one will have to search them out for himself. A technical education will be no hindrance and should be of great help, not only from the greater knowledge of scientific principles which it gives, but also in the training given in expressing one's ideas in handwriting and in speech and in the broadening influence of contact with numbers of other men with similar aims in life. But a technical training is not absolutely necessary. The works manager has to make large use of the brains of others when it comes to solving engineering problems, and will give up his own time mostly to questions of organization and administration. This can best be learned by actual practice in the art. The steps to be followed are the old-fashioned ones from the ranks of the workmen up through the petty foremanships to the higher positions of responsibility. He must consider, however, unlike the ordinary foreman, that he is studying and striving to master a definite and complicated science—a science of which something has been written and concerning which some experimental work has been done, but which is in the main a region whose prominences are unmapped and whose routes of travel are undetermined and unmarked.

The typical manager of the past, like the old-fashioned engineer, attained his eminence through unusual and fortuitous natural endowment. The efficient manager of the future, like the engineer of the present, will depend for his success on accurate analysis of the conditions with which he is confronted, and carefully considered and executed plans for accomplishing the results he desires. This is the field which to-day presents the most inviting opportunities in the mechanical world. As to how it shall be entered, each one must determine for himself. There are few places where one can serve a definite apprenticeship in the art, and no college has yet added the study of the science to its curriculum.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The Mechanical World states that a new alloy for turbine blades, containing 80 per cent copper and 20 per cent nickel, has been found to be the most satisfactory metal for the purpose as yet discovered. Of the alloys formerly used those containing zinc are said to be extremely unreliable at high temperatures, particularly when used with superheated steam.

A new German process of case hardening is claimed to give results superior to any hitherto obtained. It is said that a piece weighing 400 pounds can be hardened 0.040 inch deep, and so hard that no steel will cut it, though it may be welded. The work to be hardened is heated in bone dust powder to which is added ¾ pound of yellow prussiate, ½ pound of cyanide of potassium, and one pound of phosphorus. It is heated to a very high temperature in a closed box.

Lead wool, made in Germany, is used principally for caulking pipes, the joint being filled cold against a backing of hemp or tarred yarn. It is considered a good substitute for melted lead in making joints for hub and spigot cast iron gas mains. This "blei-wolle" is lead which has been shredded to about the size of heavy thread, collected into bundles of convenient length and of a size in proportion to the joint to be filled, twisted somewhat.—*Mining Reporter.*

Pure copper cannot be cast in sand without considerable difficulty; in fact, some deoxidizer is always used. For common copper castings from 2 to 5 per cent zinc is generally added to get sound castings; but for electrical work this is useless. The only way to get good electrical castings is to melt pure electrolytic copper in a plumbago crucible under a thick layer of charcoal. When thoroughly melted add 2 per cent silicon copper and stir it in with a stick and cast as soon as ready. Practical experience alone will show the correct temperature for casting copper in sand molds, and the proper temperature of the sand. It must not be cast boiling, but a fairly high temperature is necessary.—*Metal Industry.*

The *Maschinen- and Metallindustrie-Zeitung* has made calculations to the effect that a grown person receives through his food an amount of heat equivalent to about 12,000 or 14,000 B. T. U. a day. Only 1,200 B. T. U. are during an eight-hour day transformed into work, and the exertion of a man under these circumstances is equivalent to 0.08 H. P. Granting these figures to be correct, it is further stated that the efficiency of the steam-engine, the cost of its running being compared with the wages paid for labor, is 150 times greater than that of human exertion. No wonder then that we try to replace the brute force of man with motors of all descriptions wherever possible, and rather use the mental powers of man which no machine has as yet been able to replace.

A German manufacturer, Mr. Julius Pintsch, of Berlin, has made a number of experiments in order to ascertain the comparative durability of various metals when exposed to the heated exhaust gases from internal combustion engines. The experiments indicate that bronze and copper are least adapted to endure exposure; nickel and brass are possessed of more enduring qualities, while machine steel, nickel steel and cast iron show little depreciation from exposure. Cast iron stood the test far better when not finished, but even finished cast iron proved to be well suited for exposure of this character. The exhaust gases in the experiments referred to had a temperature of 700 degrees F. So high a temperature, of course, is not necessary for the exhaust gases if the machine is provided with a proper provision for cooling off the cylinder walls.

United States Consul Griffith, of Liverpool, has sent to Washington a brief note concerning an automatic train stop which has been in use at one or more places on the North Staffordshire Railway for two years. The apparatus, devised by Mr. T. E. R. Phillips, of Liverpool, consists of a "tripper" fixed on the sleepers between the rails which, when a signal is in the stop position, actuates a visual and an audible signal in the locomotive cab. The apparatus is also designed to apply the brakes. A great number of similar devices have been patented, but have not proved successful. One fault common to a large number is that the inventors have not considered the inertia of parts suddenly moved from a state of rest to a velocity of, say, 88 feet per second, and this is what happens to a "tripper" when struck by a train running a mile a minute.

The uses of bismuth are fairly numerous, and recently the German and French governments adopted this metal in place of lead for the cores of rifle bullets. The alloys of bismuth with lead and tin are well known for their easy fusibility and their property of expanding on solidification. Their fusibility can be increased by adding cadmium. Usually alloys contain from 20 to 50 per cent bismuth, 25 to 50 per cent lead, 4 to 20 per cent tin, and occasionally a little cadmium. There has been further research work on copper-bismuth alloys to determine their physical characteristics and to decide what percentage of each metal will make the best eutectic mixture. The structure of copper alloys containing 98 per cent or more bismuth resembles pure bismuth. Alloys generally are valued by the market conditions of their constituent metals.—*Mining Reporter.*

It appears that the Kjellin electric furnace for the production of steel has developed beyond the stage of mere experimenting, as this method is now reported to be far enough developed for utilization on a large scale in Sweden. The immense water power at Trollhattan will be utilized for this purpose and the Swedish government, which controls this water power, is expected to give the necessary permits to the exploiting company. The promoters expect to build a steel mill for producing at least 500,000 tons of steel annually, and at least one mill of the same size is expected to be erected in another part of the country. The extensive iron ore deposits in the northern part of the country will furnish all the raw material necessary. The Krupp Works are reported to have acquired the Kjellin patents for Germany and will erect large mills for their utilization.

William Marriott, an English civil engineer, makes a very interesting statement in the London *Times Supplement* regarding what has been called the "growth of iron." He asserts that during an experience of more than thirty years he has become convinced that iron increases in volume through continued heating and cooling. Mr. Marriott writes: "Rails that have fitted swing bridges with plenty of clearance have had to be shortened repeatedly year after year, and only recently I have known an instance of a swing bridge which had been open for half an hour that could not be put back until some of the ironwork had been reduced. The bridge had been built for some thirteen years and had been opened and closed during that time many hundreds of times. There is little doubt in my mind that iron heated and cooled alternately does permanently lengthen."

On September 30 the first run with a heavy electric train was made on the New York Central R.R. from Highbridge to the Grand Central Station. About November 10 it is expected to have electric engines running regularly between the Grand Central Station and Highbridge. The smoke nuisance in the tunnel will, however, not be fully eliminated for some months, as the electrification of the New York, New Haven & Hartford R.R. is not yet far enough advanced to permit steam to be abandoned on this line. Enough has already been accomplished, however, to remedy the disagreeable features of the entrance to New York by way of the tunnel, and to indicate that marked improvement in suburban traffic accommodations

will follow the completion of the undertaking. The first trip through the tunnel was made with open windows without annoyance, except from the small amount of gas left in the tunnel from preceding trains.

In establishments expecting to produce a uniformity in their output, estimating the heat of a piece of steel by the color is no more considered safe. No two men will agree as to the color of a piece in any one fire or bath. The same temperature will be differently estimated in different parts of the shop or at different times of the year or day, according to the light, and no two kinds of steel will show the same color for the same temperature. For these reasons the eye cannot be depended upon. There are, however, means for measuring temperatures used by manufacturers of fine porcelain which undoubtedly would be valuable to steel workers to enable them to ascertain with certainty the temperature in a furnace. The method consists in the use of porcelain or clay cones of various melting or softening points. Sixty different grades exist, each stamped with a number corresponding to the different temperatures at which the cones will collapse. The range of these temperatures is between 1,094 to 3,522 degrees F.—*Scientific American.*

According to the *English Mechanic and World of Science,* Messrs. Siemens and Halske, of Berlin, Germany, have recently patented an alloy which is especially suited for use as a bearing metal. They state that it is superior to the usual white metal in that it is very easily worked and particularly easily turned, that it fills up the mold completely when cast, that it possesses relatively great hardness, and, what is most important, that it has an extremely small coefficient of friction. The alloy is made by melting together approximately equal parts of cadmium and zinc, with an addition of a small proportion of antimony. The alloy can, for example, consist of 45-50 parts of cadmium, 45-50 parts of zinc, and up to 10 parts of antimony. The antimony added should not exceed 10 per cent, as otherwise the metal is too brittle. A very suitable proportion of antimony is 5 per cent. If the proportion of cadmium and zinc is considerably varied, the coefficient of friction increases, and the other good properties of the alloy are essentially prejudiced.

As a result of tests made on an experimental steel coach, the Pennsylvania Railroad has decided that all its future passenger equipment shall be made of steel. The necessity for providing non-collapsible and absolutely fireproof passenger cars for the Hudson River tunnel has led to this decision. The experimental car, it is stated, could stand any load or any collision. Its hidden frame is like a cantilever bridge, suspended on the trucks as piers, insuring safety against telescoping. The car weighs 103,550 pounds, against 84,500 pounds for the standard wooden coach; but it is found that the added weight very greatly reduces the vibration and adds to the comfort of the passengers. The decision now arrived at means that there must be rapidly constructed 1,000 fireproof cars, to be ready when the tunnel is completed. The Pullman Co. has also decided to build a steel sleeper which weighs some 25 per cent more than the standard wooden coach. The frame is of cantilever construction similar to a bridge and the flooring of the car and platform is of imitation stone spread on steel plates. Doors are of steel plate filled with cork to prevent noise, and the roof is of composite boards covered with copper sheathing, the inside lining being of composite boards covered with fireproof paint.

An explosive, which cost only one-tenth as much as dynamite, was experimented with at the Simplon tunnel, but had to be abandoned because of a peculiar disadvantage. As described by M. Jacquier, in the *Annales des Ponts et Chaussées,* it was made by soaking meal or powdered charcoal in liquid air or liquid oxygen, the powdered carbon being first packed into a case made of stout paper and covered with an asbestos wad, through which passed a paper tube to the bottom of the cartridge. Just before firing, the liquid air was poured in, and the firing was done by means of a fulminate cap as usual. Not over ten minutes should be allowed to elapse after filling before firing the cartridge, as the liquid air is gradually evaporating, and at the end of half an hour has completely disappeared. From this results one of the great advantages of the explosive, namely, that if it should miss fire, it is only necessary to wait awhile and there will be no danger whatever to the men. The dynamite used in the construction of this tunnel cost $27.50 per lineal yard of single tunnel; therefore this new explosive would have effected a great saving if it had been possible to use it. The reason why it could not be used was that it produced such great quantities of carbon monoxide (CO), that the atmosphere in the tunnel became very injurious to the workmen.—*English Mechanic and World of Science.*

ALCOHOL FROM CORNCOBS.

The Department of Agriculture is developing a new industry in the production of alcohol from corncobs, which, the department says, promises to be of much commercial value. Investigations are being made at Hoopeston, Ill., and have proved that the large quantities of corncobs which every year go to waste can be made to produce alcohol in sufficient quantities to justify the erection of a distilling plant in connection with a corn cannery. So far the department has succeeded by simple methods of fermentation in getting a yield of 11 gallons of alcohol from a ton of green cobs, and by similar methods in getting 6 gallons of alcohol from a ton of green cornstalks. A department official says that these tests show that there are 240 pounds of fermentable substance in a ton of green field cornstalks, which will yield about half of its weight in absolute alcohol. In round numbers a ton of stalks will produce 100 pounds of alcohol or 200 pounds of proof spirits. As a gallon of alcohol weighs nearly 7 pounds, there should be 15 gallons of alcohol in a ton of stalks. The addition of the corn on the cob adds further to the possibilities of alcohol obtainable from a ton of cobs, and will have its influence in bringing the quantity to a greater figure.—*Horseless Age.*

TURBO-BLOWERS.

In a paper recently presented at a meeting of the British Association for the Advancement of Science by Gerald Stoney, on the subject of "Recent Advances in Steam Turbines—Land and Marine," the author described the development of the steam turbine for driving rotary air compressors of the turbine type, which are now being used largely for blowing blast furnaces. The advantages gained are light weight, small foundation, small consumption of oil and above all, high economy of steam over the reciprocating types of blowing engines. The outfits described are generally for about 20,000 cubic feet of free air per minute, and a pressure of ten to fifteen pounds per square inch. A slightly different type is made for about 30,000 cubic feet per minute, at about one pound per square inch pressure. These blowing equipments are being used in several large iron works for dealing with the waste gases from furnaces and for driving these gases through the recovering plant, etc., an important feature being that they do not clog with tar and other matters. Since it is nearly impossible to use economically low-pressure steam at about atmospheric pressure in a reciprocating engine, the exhaust steam turbine becomes an important factor in those cases where there are non-condensing engines and other sources of exhaust steam.

WIND MOTOR FOR ELECTRIC LIGHT AND POWER STATION.

While wind power has never been very extensively used in this country (excepting in the prairie regions of the West), some European countries (and among them Holland in particular) have made use of this cheap power to a very great extent. The wind motor, however, has been used only for such purposes where a certain and constant amount of power was not a necessary condition, and where the variations in speed did not in any way interfere with the working of the driven machinery. In some cases there have been attempts made to provide the wind motors with devices which would

permit the driven machines to run at constant speeds no matter what be the speed of the wind motor itself. But even such devices could, of course, not eliminate the uncertainty of the amount of power. Of so much greater interest is therefore the report that a wind motor has been in successful operation for two years, furnishing the required power for an electric light and power plant in the small town Arkow, in Denmark. When using the wind motor for such a purpose some other kind of a motor must, of course, be kept in preparation for emergency cases. Even so, however, is the proposition of using the wind power a particularly economical one, as has been proven by this electric plant, which pays a net profit on the investment of 12.5 per cent. Regarding the efficiency of this particular motor the *Zeitschrift des Osterreichischen Ingenieur und Architekten-Vereines* states that with a wind velocity of 20 feet per second each 60 square feet of blade surface will generate 1 H. P., out of which 86 per cent will reach the electric generators.

HOLDING POWER OF RAILROAD SPIKES.

The Forest Service of the United States Department of Agriculture has completed a series of tests to determine the holding power of different forms of railroad spikes. The tests were made on ordinary commercial ties of loblolly pine, oak, chestnut, and other woods. The spikes used were of four kinds: common driven spikes, a driven spike which has about the same form as the common spike with a lengthwise channel on the side away from the rail; screw spikes of the American type; and screw spikes similar to those in use on European railroads, and differing from the American spike mainly in the manner of finishing the thread under the head.

The common and the channeled spikes were driven into the ties in the usual manner to the depth of five inches. A hole of the same diameter as the spike at the base of the thread was bored for the screw spikes, which were then screwed down to the same depth as the driven spikes. The ties were then placed in the testing machine and the force required to pull each spike was recorded.

The average force required to pull common spikes varies from 7,000 pounds in white oak, to 3,600 pounds in loblolly pine, and 3,000 pounds in chestnut. The holding power of the channeled spike is somewhat greater. For example, about 11 per cent more force, or 4,000 pounds is required to pull it from the loblolly pine tie. The two forms of screw spikes have about the same holding power, ranging from 13,000 pounds in white oak, to 9,400 pounds in chestnut, and 7,700 pounds in loblolly pine.

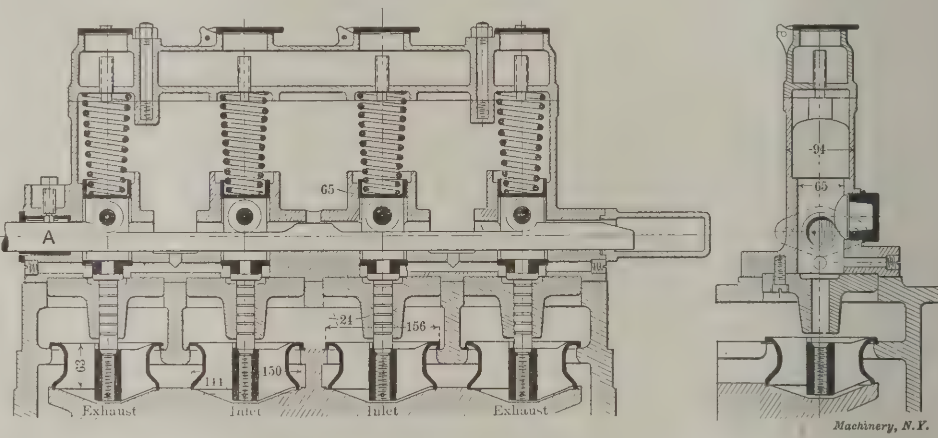
There is a marked difference between the behavior of driven and screwed spikes in knots and in clear wood. Knots are brittle and lack elasticity, so driven spikes do not hold as well in them as in clear wood. In the case of common spikes in loblolly pine the decrease of holding power in knots is as great as 25 per cent. On the other hand, screw spikes tend to pull out the whole knot which they penetrate. This increases the resistance so much that in lobololly pine the increase of holding power of screw spikes in knots is about 35 per cent over that for clear wood.

USE OF GRAPHITE TO PREVENT CREAKING.

Graphite has other lubricating uses besides its application to running journals. It is used with good results to overcome the fiendish propensity of car windows to stick, and according to *Graphite* it has been used with marked success to overcome the creaking and cracking noises made by poorly built cars when rounding curves and running over uneven track. An instance is given of a private car which had given much trouble from noise of this character. It was entirely rebuilt and all joints and seams were thoroughly covered with graphite before being put together. The result was that the creaking was entirely eliminated. Of course part of this might have been due to the improved condition of support and construction, but there is no doubt that graphite in places like this would allow the parts to move upon each other with greatly lessened friction and this means less noise and distress.

LOCOMOTIVES WITH POPPET VALVES.

The use of superheated steam in locomotives has not made any great headway owing to the fact that it does not work well with slide or piston valves. To overcome this difficulty, the Hanover Locomotive Works, in Hanover, Germany, about a year ago reconstructed a small engine that came into the works for repairs, equipping it with poppet valves of the Lentz type. The design of these valves is shown in the two sectional elevations taken at right angles to each other in the cut. The two center valves are for the inlet, and the outside ones for the exhaust. They are actuated by the end movement of rod *A*, which is made with elevations on one side to move the valves at the proper times. The valves are held closed by means of springs which do not have to be very stiff, as the valves only weigh about 8 pounds each. Tests made of this engine in comparison with another one of the same size equipped with slide valves showed a decided saving in water and fuel, 30 per cent and 19 per cent respectively, while the durability of the valves was well demonstrated by the fact that after running 11,000 miles they were in perfect running order. The operation of the poppet valves on this trial locomotive was so satisfactory that the Hanover works have constructed a larger engine of the same type.



Poppet Valves for Locomotives.

CAST-IRON WHEELS.

The Master Car Builders' Association has adopted by letter ballot the two recommendations of the committee on cast-iron wheels increasing the thickness of the flange one-eighth of an inch and changing the coning of the tread from 1 in 25 to 1 in 20. Increasing the thickness of the flange is not a new suggestion; it was first made several years ago and then dropped because it was considered impossible to run a thicker flange through the frogs and guard rails. The American Railway Association, after an investigation of the limiting conditions of modern track, has approved the change, and there are now no objections on the grounds of safety. How much strength and durability this ⅛ inch of metal will add to cast-iron wheels is yet to be determined by laboratory tests and actual service.

The committee report, in recommending the change in the taper of the tread from 1 in 25 to 1 in 20, says: "The reason for asking for the change in the taper is due to experiments that have recently been made which indicate less flange wear and a longer life to the wheel on this account."

The comments made on taper of wheel treads by Mr. M. N. Forney in his paper on the Relation of the Wheel to the Rail, presented to the Master Car Builders' Association in 1884, are pertinent:

"The relative advantages of coned and cylindrical treads of wheels have been in dispute ever since railroads were first built. Whatever advantage may accrue from the use of coned wheels is soon lost because the cone of the treads is rapidly worn away, and the wheels become either cylindrical in form or approximate thereto."

It may be, however, that the coning has more influence than

is usually accredited to it. In the topical discussion on the allowable variation in circumferences in mating wheels, it was said that if one wheel is made 1-32 inch larger in diameter than its mate, such a wheel will not run sharp. It is probable that a pair of new wheels will act on the rails like a barrel rolling on skids; that is, so adjust themselves that they will roll on points of equal diameter, and it is evident that this will be the more easily accomplished the sharper the cone of the tread. Hence, if they are brought to bear, when new, on points of equal diameter, they have the probable advantage of being liable to wear evenly and thus be of the same diameter when they are worn to the cylindrical tread. The change suggested by the committee is a reasonable one and may do something towards the elimination of sharp flanges, but the change is so small that complete relief cannot be hoped for.—*Railroad Gazette.*

REMOVING OIL FROM EXHAUST STEAM.

Abstract from a paper read by Albert A. Cary before the American Society of Refrigerating Engineers.

Separation of oil from condensed steam has been a problem of great moment, and many methods and devices have been used to effect its removal, all of which may be classified in six divisions in the first of which baffle plates or screens are used, the exhaust steam being thrown against these surfaces and allowed to pass, while moisture and free oil cling to the plates and are separated. In the second method, the steam delivered by the engine is sent through filters, generally composed of coke or some other loose material, while in the third process the steam is exhausted from the engine through a series of pipes having their lower ends immersed in water, which is supposed to wash out the oil and allow the steam to pass to its place of exhaust. A fourth method makes provision for the steam exhausted from the engines to be projected upon the surface of a large tank of water, where the oil attaches itself to the water surface, while the steam is allowed to pass on to its point of exhaust. The fifth method allows the steam with its charge of oil to be condensed and then carried to a skimming tank, where the oil is supposed to rise to the surface of the water and float off, while the cleared water is drawn from a point some distance below the surface. In the last of all the methods purification is effected by passing the oil-charged condensed steam through various filtering mediums, such as blankets, sponges, straws, excelsior, etc., and depending upon their oil-retaining properties to clear the water of its contained oil.

Recently a new process has been devised which provides for the introduction into the water of a small percentage of a special material, the nature of which is at present a secret, which has a great affinity for oil. As this material is stirred throughout the condensed steam, it takes up the oil in the same way that blotting paper takes up ink. Tests thus far made show that the separation of oil from water by this process is absolute and complete.

Oil is present in exhaust steam in three different forms: first, as a vapor; second, in finely subdivided particles of oil; third, in the form of a coating around the small particles of condensed water existing in exhaust steam. In all of the processes of oil separation, excepting the last described, it will be seen that it may be possible to ensnare and filter out the finely divided particles of oil floating in the steam and also the minute particles of water with their oil coating, but it is difficult to take care of the vaporous portion of the oil, which has proved most troublesome to the users of such devices. When oily steam is condensed, oil is found existing in the resulting water as a free oil, little clots of which, either separately or combined, float to the surface of the water. Conceiving the idea that a substance might be obtained which would have a greater attractive force for the oil than the surface of water, the inventor of the new process discovered the material already mentioned. So effective is this material that the quantity used for oil extraction is but one-twentieth of 1 per cent of the weight of the water itself, and after being introduced into the water, it has proved so light and feathery that a little stirring causes it to diffuse itself throughout the volume of oily water. This extreme lightness and ability to diffuse itself throughout the water soon causes the material to get in contact with all of the oil, which seems to leave the water suddenly and attach itself to the material. Thus, in a few minutes the water becomes cleared and all that is needed to produce a liquid as clear as crystal is a rapid filtration of the oil and water with its contained oil-absorbing material. Samples of water obtained from various power stations and subjected to this treatment have shown no trace of oil in the filtrate when analyzed by the most delicate chemical means. The material has such a capacity for oil that it can be used several times before a new charge is required, and, further, the cost of the original material is small.—*The Engineer.*

THE ROTARY GAS ENGINE.

W. L. Chambers, in The Engineer, October, 1906.

Much on the possibilities of the gas turbine is printed in engineering magazines of the day, and it must be admitted that there are certain advantages to be gained in the use of that form of motor. At the same time there are certain obstacles in the way of its successful operation which make the turbine impracticable, at least in almost every form yet devised. Chief of these difficulties is the inability to keep the temperature of the blades below the point of oxidation, which renders them brittle and useless. Several ways of overcoming this difficulty have been suggested, but no one so far seems to have been able to surmount the mechanical obstacles presented. A little study of the faults of the common reciprocating gas engine has led the writer to the belief that there is a greater chance of success in the field of the rotary gas engine of the explosion type than in the turbine. The rotary has no greater cooling problem than the reciprocating engine, and it is quite possible to get one, two, or even three explosions per revolution, instead of one every alternate revolution, or, at best, one each revolution, as in the ordinary four-cycle and two-cycle types.

If, in the reciprocating engine, two impulses are obtained per revolution, it must be in the two-cycle, double-acting type with pump and one cylinder or two-cylinder, two-cycle, single-acting crosshead type or four-cylinder, four-cycle type. Any of these have a great multiplicity of parts and the first two are open to the serious fault of all two-cycle engines, viz., that of imperfect scavenging, which allows a large amount of burned gases, varying with the back pressure of the exhaust, to be mixed with the incoming charge. This mixture of the gases is very liable to cause back firing. In the four-cycle type nearly a fixed amount of burned gas is left in the ports, explosion chamber, etc., which as in the two-cycle is mixed with the new charge. This amounts to from one-sixteenth to one-quarter of the entire volume of the cylinder, varying with the compression. If the compression is high, the amount is less in proportion, but increases rapidly as the compression is lowered. No such trouble would be encountered in the rotary, as it could be made to scavenge almost perfectly and obtain the full benefit of a clean charge.

Even more than the turbine the rotary would reduce the size per unit of power over the common type, due to the fact that the rotor of the turbine would of necessity have to be made large to keep down the angular velocity, while the rotary could be made as compact as possible. The greatest advantage, however, of the rotary over the reciprocating engine would be, that the power of each impulse is applied constantly on the tangent; hence, the turning moment would be always equal to the pressure at any point, while in the reciprocating type the turning moment varies for small close-connected engines approximately as given in the accompanying table:

	Pressure.
Beginning of stroke	0.00
⅛ of stroke	0.444
¼ of stroke	0.668
⅜ of stroke	0.84
½ of stroke	1.00
⅝ of stroke	0.75
¾ of stroke	0.60
⅞ of stroke	0.44
Full stroke	0.00

This variation is due to the imperfection of the crank and connecting rod as a means of power transmission. The above factors coupled with the constantly varying pressure, which

falls rapidly after the beginning of the stroke, make the average turning moment only about 0.45 of the average pressure on the piston. The rest of the pressure, about 0.55, is simply lost in strains and friction.

Another advantage of the rotary over the common type is its compactness, the rotary having something like 8 to 1 the advantage in cubical space occupied, and about 3 to 1 in floor space.

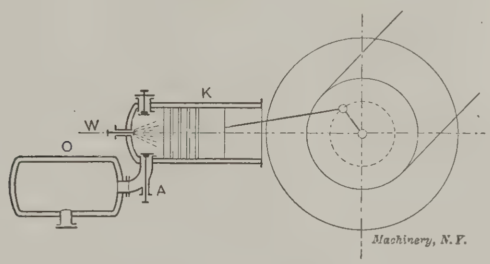
Owing to the comparatively small cylinder volumes to piston areas in some forms of rotaries, the volume of gas consumed would be, theoretically, nearly 40 per cent less than in its reciprocating competitor. In practice it would in all probability not more than equal the common types, owing to the difficulty of keeping rotary cylinders tight enough to prevent leakage without undue friction.

There is one thing in the rotary, however, that promises to be a little difficult, and this is its lubrication. But this is far from an impossible problem, although a somewhat complicated one owing to the number and location of places that require oil.

NITRIC ACID AS A GAS ENGINE BY-PRODUCT.

Cassier's Magazine, August, 1906.

One of the great chemical and economic problems is the discovery of a commercially profitable method of fixing the inert gas, nitrogen. This element is a valuable one, being used in various combinations in the arts, and having an especially broad field of usefulness as a plant food. The problem of obtaining it, however, in a form suitable for use is a very difficult one. Mr. F. E. Junge contributes to *Cassier's Magazine* a description of a process developed in Germany in which the gas engine is used as a medium for performing this highly valuable but difficult operation.



Nitric Acid as a Gas Engine By-product.

After discussing the various methods for the fixation of nitrogen it can be shown that the most available compound for this purpose is nitric oxide, which is composed of equal quantities of nitrogen and oxygen. This combination takes place at high temperature. After the gas is cooled to a low temperature it will absorb another atom of oxygen from the surrounding air, forming nitric dioxide and this will in turn dissolve in warm water to form nitric acid according to the formula:

$$2\,NO_2 + O + H_2O = 2\,HNO_3.$$

This last action is effected by spraying the water into the gaseous mixture in finely divided form. We thus, in this process, have a very simple means of making HNO_3 by the exclusive employment of water and air, both of which can be had practically without cost, and in unlimited quantities, if it only be possible to find a cheap and realiable method of making NO.

The two constituents of this substance, nitrogen and oxygen, are both present in the gas engine cylinder as constituents of the air drawn in with the charge. When analyzing the exhaust gases of an ordinary gas engine it will be noted that if the engine is running very hot the exhaust shows a marked smell of nitric oxides, and it is obvious that under specially-prepared conditions this phenomenon may be made to appear regularly. At the highest temperatures, which are almost coincident with those of maximum pressure, part of the atmospheric nitrogen will combine with the surplus oxygen to form NO. To avoid decomposition of this combination the mixture must be guarded against gradually cooling down by adiabatic or other expansion—in other words, the gases must be quenched by the sudden injection of cold water. The quantity and distribution of this water injection will, therefore, determine the drop of temperature and pressure of the gases in the compressor cylinder, whence they are allowed to escape through a valve into an exhaust vessel, where they are mixed with water and air to produce first NO_2 and then HNO_3, according to the formula given above. The accompanying cut shows diagrammatically the apparatus employed, *K* being the cylinder of the gas engine, *W* the water inlet valve for quickly cooling the nitric oxide, while *A* is the exhaust valve leading into the chamber *O* where the nitric acid is formed.

The questions that naturally arise when studying this process are, first. the time or duration of high temperatures sufficient to produce NO in such quantities as will make the process an economical one; and second, whether the energy absorbed as negative work for carrying out the mechanical process of compression and the establishment of high pressures is low enough to be a negligible quantity in the commercial application of the invention. Herr Häusser, who described the process before a branch of the Society of German Engineers at Kaiserslautern, produced evidence tending to show that neither of these were of sufficient importance to make the process an unprofitable one. An attractive feature of the invention and one that is likely to hasten its industrial exploitation lies in the fact that the principle underlying it is extremely simple and can be carried out by almost any owner of a gas engine without increasing the initial cost, operating expenses, floor space, or complexity of the plant in any but a very small degree. The amount of power produced from a given engine with a given amount of fuel is of course reduced, but it is claimed that the value of the nitric acid generated exceeds the cost of the power lost to such an extent as to make it seem that the process stands on a sound commercial basis, as far as Continental conditions, at least, are concerned.

THE BEGINNING OF MECHANICAL VENTILATION AND HEATING.

Compiled in part from an article by R. T. Crane in the Valve World.

The history of heating and ventilating engineering in this country commences with Joseph Nason, who, upon his return from England in the latter part of 1842, began the introduction into this country of the Perkins system of hot-water heating, with which Mr. Nason was thoroughly familiar, having been for some years, while in England, in the employ of Mr. Perkins. In 1846 a radical departure in the method of heating—in this country at least—was made by the warming of the Boston custom house by means of mechanical propulsion of air. A large coil of ¾-inch pipe was massed in the basement, and from it to the several registers were run ducts of sufficient capacity to carry the warmed air. This plan of warming, while not new in France, was entirely novel in this country, and was the beginning of all subsequent systems in which fans were employed for distributing air. The fact that this plan of warming had already been employed in France does not detract from the credit due to Mr. Nason, as there is no evidence that while abroad he went to France, and it is highly probable that he was not familiar with the progress that had been made in that country. In 1855, in which year extensive alterations of and additions to the United States Capitol at Washington were in progress, Mr. Nason, at the request of General Meigs, then in charge there, went to Washington and planned a system of ventilating and heating for the Capitol. This was the first really scientific and complete job of the kind done in this country. Mr. Nason, as this job at the Capitol shows, had a thorough knowledge of the business, as it was then well known, and was at the time unquestionably the best informed and most experienced person on heating and ventilating in the United States.

The apparatus installed under Mr. Nason's direction consisted primarily of a heating surface of wrought-iron pipe, over which air was forced by means of two specially designed centrifugal fans, and conducted through ducts to the rooms to be heated and ventilated. This plan of having a large amount of heating surface located in one place and the air blown through it, the heated air being then conducted to such

places as it was needed, was for some years the favorite mode of heating. Some years after, a job of this kind was put in the new post office at Washington. It was also placed in several insane asylums.

In the late fifties B. F. Sturtevant began his work in Boston, which eventually led to his building up the largest blower business in the world. In the course of ten years he developed the blower and its uses to such an extent that it became a recognized factor in satisfactory ventilation. He replaced the United States Capitol fans with others of more modern design, and about 1870 entered the market with a unit combination of fan and steam heater. From the somewhat crude design of that day has been evolved the present type of fan blower heating apparatus to be found in every important public building and in thousands of industrial plants throughout the world.

BRIQUETTING TESTS OF THE FUEL-TESTING PLANT OF THE UNITED STATES GEOLOGICAL SURVEY.

The United States Geological Survey has conducted a number of tests on the briquetting of fuel at its fuel-testing plant, St. Louis. The results of these tests are summarized in a preliminary report recently issued. In the making of coal briquettes, the binding work is best performed when the particles of coal are coated and the void spaces are filled with binding material. This is best accomplished when the temperature of the mixture before compression is raised sufficiently to liquefy or vaporize the binder. The relation between the coal and the binder seems to be physical rather than chemical. The more important requisites of a suitable binding material for briquettes are as follows:

1. It must be inexpensive because of the small difference in the United States between the prices of slack or fine coal and those of lump coal. 2. It should be capable of abundant production in different parts of the country to avoid the necessity of long transportation. 3. It should be of such character as to make it easily handled and applicable at working temperatures. If used in solid condition, as in the case of pitch, the melting point should not be lower than the temperature of hot summer days nor ordinarily above that of live steam. 4. It should hold the briquette together strongly, not only during ordinary handling and transportation, but also during protracted exposure to weather and while burning. 5. The binder should not add appreciably to the ash of the coal, nor increase the clinker formation in the ash. It should not give off fumes, nor seriously increase the smoke in burning the briquettes. 6. The binding material should increase, or certainly should not decrease, the heating quality of the coal which is used in the manufacture of briquettes.

The condition which more than any other has prevented the development of the briquetting industry in this country is the low price of bituminous coal and especially the small difference between the price of the lump coal and that of the slack, or fine coal.

The high cost of the pitch which is generally used as a binding material is also one of the barriers existing in the way of the development of this industry. One of the purposes of the present investigation is to discover, if possible, some cheaper binding material, and the outlook in that direction is encouraging. The cost of manufacturing briquettes in France, Germany, Belgium, and England, including all necessary items except that of the coal and binding material, is estimated to range from 25 to 50 cents per ton, varying with the local conditions. Where pitch is used as a binder, as is almost universally the case in each of these countries, its cost for a ton of briquettes may be said to range from 50 to 80 cents. How far this cost may be reduced by the use on a commercial scale of cheaper binders remains to be seen. The most favorable outlook for the development of this industry in the United States is in connection with the use of briquettes in locomotives and in domestic furnaces and stoves. It can hardly be expected that, at anything approximating existing prices, briquettes can be manufactured for successful use in the ordinary power-plant furnaces of the country.

The briquettes experimented with weigh about 3½ pounds, and were made of such a size as would most nearly fulfill the requirements of stationary and locomotive boiler practice.

In the laboratory investigations, various substances were tested as binding materials in the manufacture of briquettes, both as to the possibility of their being used with the different varieties of bituminous coal and as to the percentage of each binder yielding the best results with each coal. These investigations related not only to the nature and the amount of the binder necessary for making satisfactory briquettes with each of the several coals tested, but also to the extent to which the binding quality of certain of these materials might be improved by the admixture of another binding material or another variety of coal.

The binders may be divided into two general classes—inorganic and organic. The former comprised clay, lime, magnesia, magnesia cement (magnesium oxide and magnesium chloride), plaster of Paris, Portland cement, natural cement, slag cement, and water glass. The organic binders consisted of wood products, sugar factory residues, starch, slaughter house refuse, tars and pitches from coal, natural asphalts and petroleum products.

The use of inorganic binding materials, such as those mentioned above, is not likely to prove practicable.

The use of clay, lime, and cements as binding materials was found entirely unsatisfactory, for the reason that they add largely to the ash constituent of the briquette. The briquettes made with these materials as bond went to pieces on exposure to water and weather, and their waterproofing, by soaking in oils, etc., was found difficult and expensive. In the tests with plaster of Paris, from 2 to 12 per cent of this material being used as a binder, the briquettes made were hard but brittle, and quickly disintegrated on exposure to moisture. None of the sugar-factory residues, namely, beet pulp, lime cake, beet-sugar molasses, and cane-sugar molasses, were considered satisfactory as binding materials for the reason that the briquettes made with them disintegrate on exposure to the weather, and no inexpensive waterproofing has as yet proved satisfactory on a commercial scale. Nor were any of the wood products, including rosin, pitch, pine-wood tar, hard-wood tar, Douglas fir tar, wood pulp, and sulphite liquor from paper mills when used alone regarded as satisfactory, though some of these materials used in combination with other binders gave results of some promise, and deserve further investigation.

The test made in which 0.5 to 3 per cent of starch was used as a binding material with different coals gave briquettes which were strong, burned smokelessly and held together in the fire until completely consumed. These briquettes, however, went to pieces when wet or exposed to the weather for a considerable time. Experiments as to the possibility of cheaply waterproofing these briquettes were sufficiently successful to warrant investigation in this direction.

Slaughter house refuse proved unsatisfactory for a number of reasons.

The tests with coal tars and the different grades of pitch made from these tars indicate that probably in the pitches the most satisfactory binders for the manufacture of briquettes will be found; and that these can be made at such a price as will bring the cost of the binding material used to not more than 50 to 75 cents per ton of briquettes. In the investigation of the asphalts as binding materials, impsonite from Indian Territory was found to be rather unsatisfactory, though in a number of tests with non-coking coals the result was improved by the addition to such coal of from 5 to 10 per cent of impsonite in addition to from 3 to 5 per cent of ordinary pitch or some other binding material. From 4 to 8 per cent of gilsonite and other asphalts from Utah gave fairly satisfactory results as a binder. This material is said to exist in Utah and elsewhere in large quantities, and while the price is at present too high to permit its extensive use as a binder, doubtless should the demand for it in this connection increase the deposits would be opened up to such an extent that it might be sold at lower prices. Experiments were made with several other asphaltic materials, and though the results were such as to warrant further investigation they were not altogether satisfactory. Asphaltic tar yielded fairly good results as a waterproofing material in briquettes made with starch. Asphaltic materials yielded the best results in waterproofing.

Crude petroleums have been tested as binding materials, with satisfactory results. The asphaltic petroleums were used successfully in waterproofing briquettes made with a starch binder, though it is doubtful whether this practice would prove entirely satisfactory in operations on a commercial scale.

Water-gas tar, which is obtained from illuminating gas plants, was not tested sufficiently to give satisfactory results, but it is believed that this material could be used as a binder if properly mixed with other somewhat similar materials. It is necessary, after this material is mixed with the coal, that the mixture should be raised to a sufficiently high temperature to liquefy and perhaps even to vaporize the tar. The cost of this binder would be from 45 to 65 cents per ton of briquettes.

TEST OF THE LEA-DEGEN TWO-STAGE CENTRIFUGAL PUMP.

Report by Prof. James E. Denton, of Stevens Institute of Technology.

For about two years Messrs. Julius Degen and E. S. Lea, Trenton, N. J., have been conducting experiments and taking out patents on centrifugal pumps, with the view of increasing their efficiency and at the same time reducing the cost of manufacture. Under the present condition of manufacturing ordinary centrifugal pumps a set of patterns is required for each size of pump, which, of course, means a great number of patterns to cover the requirements of pump users. The Lea-Degen design simplifies the problem by dividing the pump casing horizontally (for the purpose of assembling and examination) and vertically in the plane of each runner for the purpose of making a pump consist of as many runner units as are required for the character of service. They have succeeded in so designing their patterns that approximately 150 sizes and capacities of pumps are produced with ten sets of patterns. An interesting feature of this pump, referred to in our July, 1905, issue, is the method employed for balancing. This will be described later on in the account of the test. The following is an account of a test made by Prof. James E. Denton, of Stevens Institute of Technology, dated July 24, 1905.

General Description of the Pump.

The general design of the pump tested is exposed by Figs. 1 and 2, which show it to consist essentially of two shrouded runners, or pump wheels, mounted on the same shaft in a double case. The case is so partitioned that the water is drawn from the source of supply and put under pressure by the first wheel, and then delivered to the suction chamber of the second wheel. The second wheel then imparts to the water the same amount of energy it receives from the first wheel, thereby increasing the pressure, and then delivers the water into a spiral discharge conduit terminating in a diverging nozzle connecting with the main pipe. The outline dimensions of the pump follow:

Diameter of suction pipe	10 inches
Diameter of discharge pipe	10 inches
Outline diameter of each wheel	24 inches
Number of blades	8

Novel Features of the Pump.

The special features of the pump which represent patented advantages are as follows:

1. The case is divided through its horizontal diameter by bolted flanges so that its top half can be quickly freed, and lifted off, without disturbing either suction or discharge connections, thereby affording easy access to the internal parts of all the stages at once.

2. By means of bolted circumferential divisions of the case, provision is made for either using the suction and discharge end of a case together as a single-stage pump, or for adding as many intermediate sections as may be necessary to afford any desired pressure at any fixed speed. Additional stages can therefore be installed after a pump has been in operation without wasting any parts of the existing case.

3. A special arrangement of double cup-leather packing is used for both the suction and discharge ends and for the intermediate sections. The cup leathers are held against a flat collar, on extended pump-wheel sleeves, in such a manner that the leathers can follow up as they or the collars are worn, or the shaft may be shifted at will in either direction, with the leathers following, without changing the location of the leather with relation to the shaft collar, thus making a practically water-tight joint at all times. A spiral spring is used, between each pair of cup leathers, to insure their seating against the collars before pressure is put on the pump. Provision is made for setting out the leather packing on the suction end of the shaft by the water pressure of the high side of the pump.

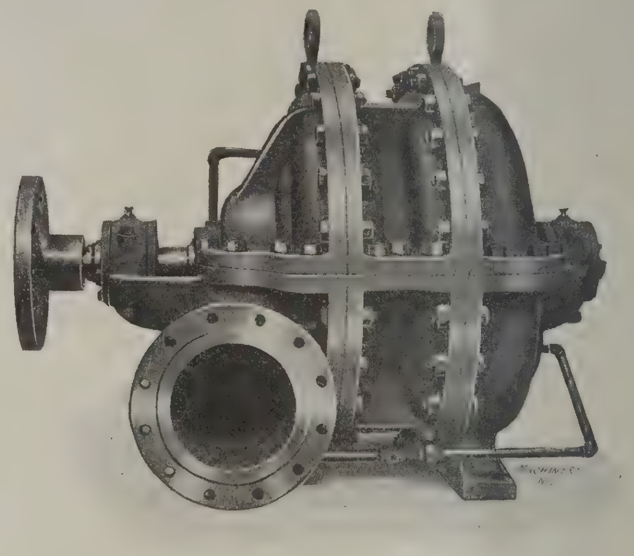


Fig. 1. Lea-Degen Centrifugal Pump. Note "Unit" Design of Shell Parts.

4. On the outside of main bearings, at each end, is placed a ball thrust-bearing, with adjusting collars, for shifting the shaft endways to balance the end-thrust of the pump runners. The balancing is accomplished by means of variation in the width of water space, on both sides of the wheels between the rim of wheel and the case. Experiment showed that as the wheel was moved laterally in the case, the pressure between the wheel and case increased on the side where the clearance was greatest, and was reduced on the opposite side.

General Description of Tests.

The pump was driven by a General Electric direct-current multipolar dynamo of 385 amperes and 220 volts' capacity used as a motor, and directly connected to the pump shaft.

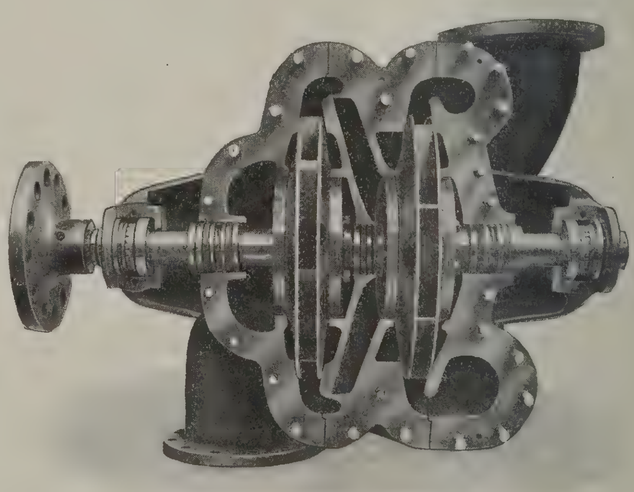


Fig. 2. Lea-Degen Centrifugal Pump, showing Runners.

It was arranged (Fig. 3) to lift water by suction, about seven feet, from a well fed from the Raritan Canal, and to deliver it through a 10-inch throttle valve, *C*, to a 6½-inch bell-shaped nozzle, *H*, to a weir tank, *M*, which was about 25 feet long by 10 feet wide and 10 feet deep, whence the water flowed through a rectangular notch 3.02 feet wide in a ¼-inch beveled iron plate, *L*, set in the middle of the end of the tank about 7 feet above the bottom.

A pitot tube, *I*, was applied under the nozzle, and its indica-

tions used as a means of quickly adjusting the discharge of pump to the several amounts of flow necessary for the tests.

The amount of water flowing was calculated from the weir height by the Francis formula:

$$Q = 3.33\ (l - 0.2\ h)\ h^{\frac{3}{2}}$$

The weir heights were taken with a hook-gage, *O*, in a barrel, *N*, communicating with the tank by a 2-inch pipe, *P*, having an open end square with the flow of water at a point 13 feet back of the notch. The surface of the water approaching the weir was made perfectly smooth by means of a grill lattice 6 feet from the discharge nozzle, and dam-boards set by trial.

The zero of the hook-gage was determined daily with a straightedge and checked by a surveyor's level. Readings of the gage could easily be made to 1-64 inch. The leakage of the weir was frequently determined. It remained practically constant at 18 gallons per minute, which was added to the quantity calculated by the weir formula.

At each speed the steps in the determination of the maximum efficiency were as follows:

The pump was primed† with the throttle valve *C* (Fig. 3) closed.

The throttle valve was then set wide open, and connection made with the mercury columns, which had been previously filled with water between the mercury and the cock connecting them to the main pipe. The speed was then adjusted by a rheostat, and the required data were observed at five-minute intervals until the average of the readings was practically constant. The throttle valve was then reset to secure a series of reduced rates of flow, which, by preliminary tests, were known to be sufficient to establish the "gallons-lift" curve (Figs. 4, 5 and 6). No data were recorded at a speed varying more than two revolutions from the assigned speed, a skilled assistant devoting his attention to this point. After the "gallons-lift" curves were secured, the pump was disconnected from the motor, and the power of the latter absorbed by a prony brake over the same range of watts applied to drive the motor during the pump tests. Thereby the "brake horsepower-watts" curves‡ (Fig. 7) were established.

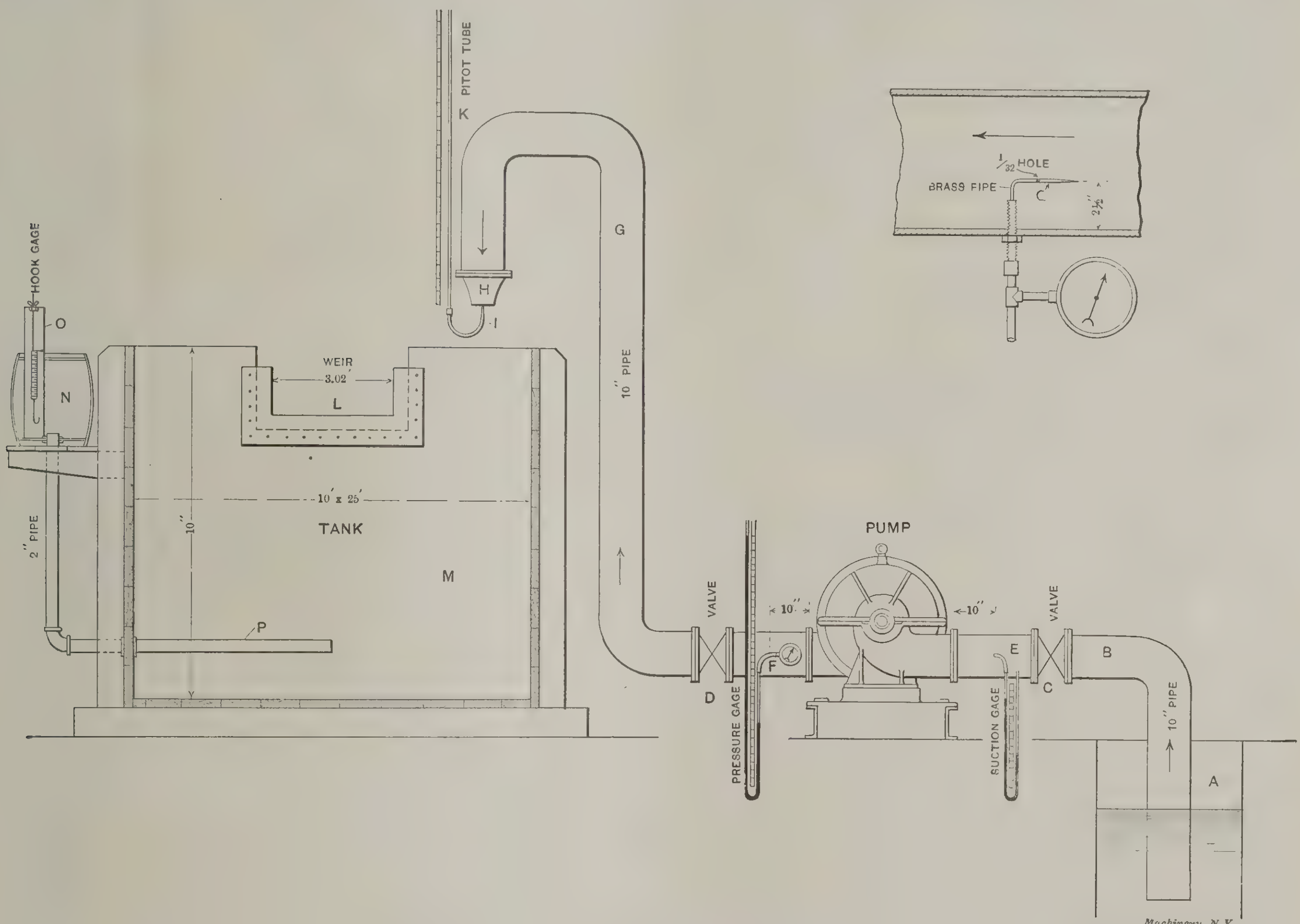


Fig. 3. Diagram of Apparatus for Testing Lea-Degen Centrifugal Pump.

The total lift of the pump was determined by adding the vacuum shown by a mercury gage, *E*, to the pressure above the atmosphere shown at *F*, the pipe diameter being the same at both points.

At *F* both a pressure gage and a mercury tube were used during most of the tests, the gage being calibrated by a Crosby testing apparatus. To secure a smooth surface in the main pipe for measuring the pressure at *E* and *F* the latter was taken through a 1-32-inch hole, *Q* (see sectional view), in the top of a ⅛-inch polished brass tube,* with a pointed closed end lying against the current.

Method of Procedure.

The pump was designed by Mr. Degen for practically equal efficiency for the range of speed between 400 and 600 revolutions per minute. Therefore, an efficiency test was made at 400, 500, and 600 revolutions, respectively.

From these curves the horsepower corresponding to the watts applied to drive the motor during the pump tests, was determined, and taken as the horsepower to drive the pump (column 6, tables 1-3).

The useful work of the pump is (column 5),

$$\text{Water horsepower} = \frac{\text{Pounds water delivered per minute} \times \text{total lift in feet}}{33{,}000} =$$

$$0.000252 \times \text{gallons per minute} \times \text{total lift in feet.}$$

The total lift is the sum of the suction vacuum (column 4), and the pressure (column 3), in front of the throttle valve, expressed in feet of water.

* The tube was located 2½ inches from the side of the pipe. Experiment showed that at the highest rate of flow there was an increase of ½ pound pressure when the 1/32-inch hole was moved from a point 3⅞ inches inside the pipe to a point ½-inch within it. The position of the tube in the pipe is not a factor in the test since it was the same at *E*, and *F*, and the velocity was equal at these points.

† The priming was done by water from the city mains acting through a 1¼ Penberthy ejector, no foot-valve being used on the suction pipe.

‡ For 400 and 500 revolutions these curves are straight lines, but at 600 revolutions, the straight line does not maintain, probably because the speed had to be regulated by changing the position of tne brushes.

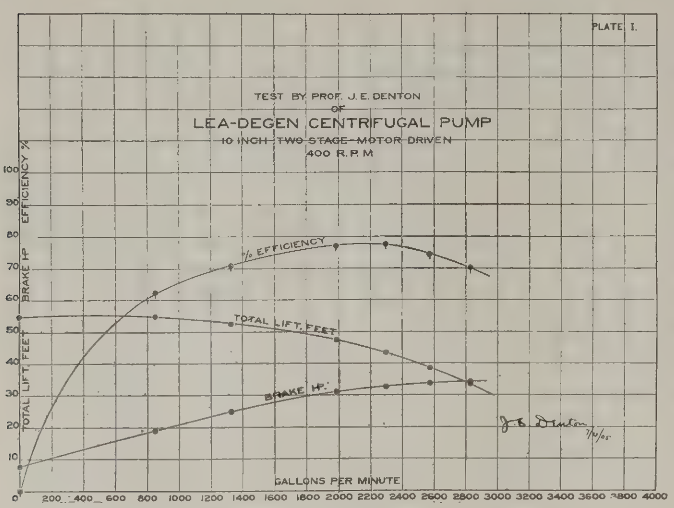


Fig. 4. "Gallons-lift" Curve for 400 R. P. M. Lea-Degen Centrifugal Pump.

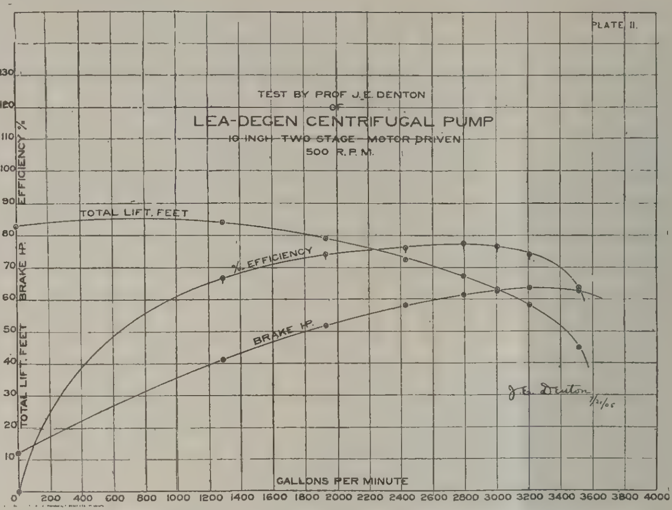


Fig. 5. "Gallons-lift" Curve for 500 R. P. M. Lea-Degen Centrifugal Pump.

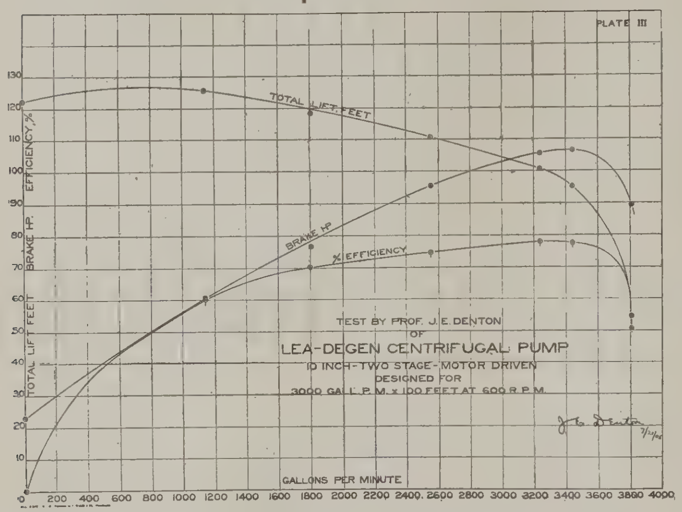


Fig. 6. "Gallons-lift" Curve for 600 R. P. M. Lea-Degen Centrifugal Pump.

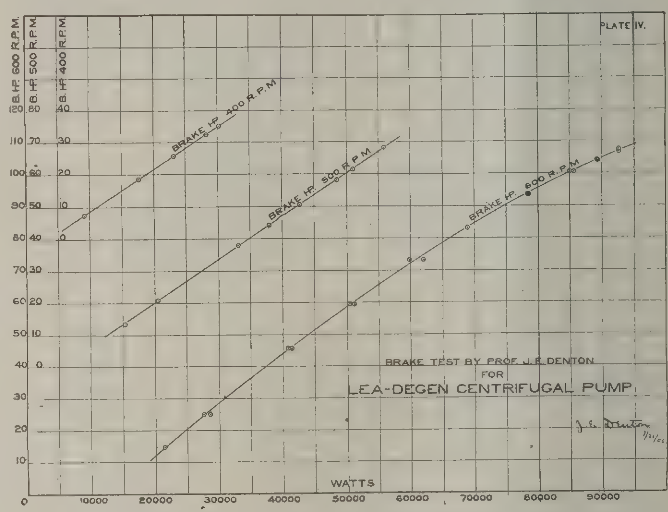


Fig. 7. "Brake-horsepower watts" Curve, Lea-Degen Centrifugal Pump.

RESULTS OF PUMP TESTS.

Table I. 400 Revolutions.

Weir Gallons per min. G	Total Lift, feet.	Outlet Press, feet.	Suction Lift, feet.	Water Horse Power	Horse Power to Drive Pump.	Weir Height, feet. h	Pitot Ratio, C	Watts to Drive Motor.	Revolutions per min.	Efficiency. E
1	2	3	4	5	6	7	8	9	10	11
2828	33.65	20.29	13.36	24.08	34.22	0.754	0.982	29,830	401	70.37
2574	38.55	26.32	12.33	25.10	33.78	0.707	0.981	29,484	402	74 30
2296	43.63	32.41	11.22	25.34	32.61	0 653	0.988	28,576	400	77.70
1984	47.49	37.29	10 22	23.84	30.96	0.590	0.992	27,300	401	77.00
1328	52.39	43.98	8.41	17.60	24.86	0.448	....	22,570	401	70.79
852	55.00	47.69	7.31	11.86	19.02	0 330	....	18,042	401	62.42
0	54.93	48.16	6.77	0	7.7	0.0	....	9,400	402	0

Table II. 500 Revolutions.

3517	44.81	27.85	16.96	39.87	62.58	0.878	0.965	51,700	501	63.71
3207	58.09	43.17	14.92	47.13	63.64	0.823	0.987	52,496	500	74.05
3005	63.12	49.28	13.84	47.99	62.63	0.787	0.984	51,736	500	76.62
2794	67.44	54.48	12.96	47.67	61.41	0.748	0.996	50,830	500	77.62
2428	72.38	60.84	11.54	44.46	58.16	0.678	0.995	48,400	500	76.04
1929	79.09	69.26	9.83	38.60	51.99	0.578	0.989	43,800	500	74 24
1289	84.26	76.16	8.10	27.48	41.11	0.438	....	35,680	501	66.84
0	83.04	76.27	6.77	0	12.07	0.0	....	14,012	502	0

Table III. 600 Revolutions.

3806	50.65	32.11	18.54	48.58	89.40	0.928	0.974	74,365	600	54.34
3440	95.13	34.10	16.36	82.47	106.50	0.864	0 973	92,115	600	77.44
3235	100.71	36.97	15.31	82.10	105.30	0.828	0.987	91,052	600	77.97
2554	110.46	42.45	12.40	71.09	95.40	0.703	0.997	80,220	600	74.52
1805	118.21	46.95	9.76	53.77	76 60	0.553	0.998	63,300	598	70.19
1139	125.67	50.90	8.09	36.07	60.10	0.401	....	51,012	599	60 02
0	122.08	49.80	7.04	0	22.90	0.0	....	26,880	600	0

The efficiency is then (column 11):

$$E = \frac{\text{Water horsepower}}{\text{Horsepower to drive pump}}$$

The prony brake was of the two semi-circular, solid-block type applied to a 28-inch pulley, with a 6-foot lever-arm acting on a knife-edge on a tested platform scale. It was carefully balanced, with its pulley, by mounting the whole com-

bination, with a mandrel through the pulley, on straightedges. A copious stream of water applied to a nipple in the top block, through a long vertical flexible hose, and a hand-tightening wheel, with a leverage of 1,000 to 1, enabled the highest loads to be maintained indefinitely with a very steady equipoise of the scale-beam. The electrical readings were made from a Weston instrument from the laboratory of the Stevens Institute.

The ratio of the quantity of water given by the weir to that given by the pitot tube is shown in column 8. This ratio is the value of the coefficient C in the formula for cubic feet per second.

$$Q = C \times \text{area of nozzle} \times \sqrt{2\,g \times \text{pitot head.}}$$

Conclusions.

The tests show that the pump afforded the following results under conditions of maximum efficiency:

At 400 revolutions, 77.7 per cent efficiency, with a capacity of 2,296 gallons under 43.6 feet lift.

At 500 revolutions, 77.6 per cent efficiency, with a capacity of 2,794 gallons under 67.4 feet lift.

At 600 revolutions, 77.97 per cent efficiency, with a capacity of 3,235 gallons under 100.7 feet lift.

In round numbers, therefore, the capacity at maximum efficiency is directly proportional to the revolutions, and the lift, or head, is proportional to the square of the revolutions. At each speed the efficiency averaged more than 76 per cent over a range of 600 gallons of capacity for the lower two speeds, and 900 gallons at the higher speed, the head remaining nearly constant.

Test of Effect of Altering Clearance upon the End Thrust.

Pipes tapped into the case on either side of the high wheel were connected to the two ends of a U mercury tube. With the shaft in the position in which it had been adjusted for the test, there was no difference of pressure shown by the mercury, and there was no evidence of labor in the thrust bearings for this position during the several days of operation of the pump for the tests of efficiency. When the shaft was moved 7-32 inch laterally from this position, the mercury showed an excess of pressure of ⅞ inch on the side of the wheel upon which the clearance had been increased.

[The balancing chambers on either side of the wheel are in communication with the annular discharge space surrounding the circumference of the wheel, communicating therewith by the clearance spaces referred to. If these clearance spaces are considered to be of considerable width it is clear that a pressure equal to that in the annular discharge space will exist in the balancing chambers, but if the clearance on one side of the wheel becomes smaller, owing to lateral movement of the runners, there will be a reduction of pressure on that side due to the sucking action of the jet of water emanating from the mouth of the wheel. This sucking action, therefore, will, reduce the static pressure of water in the balancing chamber on the side having the clearance reduced, or, putting it as above, the pressure will be greater on the side which has the greater clearance. The arrangement for balancing the end thrust is, therefore, not an automatic one, in the sense that the runners seek a balanced position; the shaft and runners are adjusted by hand until the end thrust is zero, and is then kept in this neutral position.—Editor.]

MACHINERY COMPETITION OF UNITED STATES AND GREAT BRITAIN.

Consular Report No. 2665.

The two great machinery-producing countries of the world are the United States and the United Kingdom. The American leadership has been in new and skillful mechanisms to save labor costs, the British in bulk of production and export. Both countries are rapidly increasing their foreign sales, as the following tables of comparison indicate, the American statistics being for the fiscal year ending June 30, 1906, which show 18 1/3 per cent increase over 1904, while the British figures of export for the first six months of 1906, show 24 1/3 per cent increase over the same months of 1904.

Great Britain does not compete with America in the trade for cash registers and typewriting machines, laundry, shoe,

AMERICAN EXPORTS, FISCAL YEAR ENDING JUNE 30.

	1904.	1906.
Cash registers	$1,836,233	$2,496,891
Electrical machinery	5,645,809	7,869,137
Laundry machinery	553,912	674,398
Metal-working machinery	3,716,709	6,445,612
Printing presses	1,396,746	1,577,061
Pumping machinery	2,703,397	4,210,624
Sewing machines	5,623,423	7,272,868
Shoe machinery	1,071,090	1,487,140
Locomotives	5,261,422	6,375,229
Boilers and engine parts	2,169,753	2,484,003
Stationary engines	1,069,401	1,485,093
Woodworking machines	738,609	945,832
Typewriting machines	4,537,125	5,126,374
Agricultural machinery and implements	22,749,700	24,554,427
Other machinery	19,906,662	28,437,235
Total	78,979,981	93,448,397

BRITISH EXPORTS, FIRST SIX MONTHS OF YEAR.

	1904.	1906.
Locomotives	$4,511,480	$6,418,570
Agricultural engines	2,499,887	2,782,545
Other engines	5,452,889	9,068,169
Agricultural machinery	2,582,068	2,904,891
Sewing machines	5,615,065	3,790,838
Mining machinery	2,138,014	1,757,201
Textile machinery	11,627,723	15,339,841
Electrical machinery	1,045,587	2,132,797
Other machinery	14,656,604	20,641,474
Total	52,129,317	64,836,326

and pumping machinery. In other lines competition between the two countries is keen. The United States exports of locomotives increased by 20 per cent from 1904 to 1906, while British exports increased 35 per cent. The most notable American increase was in the Central American States, where $37,150 worth of locomotives were sent in 1904, $60,810 in 1905, and $1,131,930 in 1906, while sales to Japan increased from $624,873 in 1904, $1,276,045 in 1905, and $1,996,398 in 1906.

* * *

TURBINE TROUBLES NOT SERIOUS.

In your issue of June, 1906, you devote some space to turbine troubles. I trust I may be pardoned for calling your attention to the prominence which you have given to certain of them. Quoting:

"The most serious trouble experienced with the Parsons turbine has been the tearing out of more or less of the blading upon occasions when the rotor and stator came into contact through some accident or otherwise."

Appearing at the beginning of this article this would lead one to the belief that the trouble was really very serious indeed, and was to be expected at any moment, a state of affairs which would not be altogether conducive to the peace of mind of a power plant manager who had to depend absolutely upon his turbines.

Now, no one will deny that blading troubles have occurred in the past and will occur now and then in the future from various causes, just as the flywheels break, connecting-rods give out, bearings get hot, cylinder heads crack, etc., in a steam engine that does not get proper attention. But it is important to bear in mind that blading troubles, while sometimes serious in themselves, are quite insignificant in proportion to the total experience that has been achieved in the turbine art.

As an example of the relative unimportance of blading trouble as compared with the breaking of similar parts in a steam engine (even so small a break as a piston ring), several cases may be cited in which a number of rows of blades have been lost while the machine was in service without being observed by the attendants and with no noticeable effect on the running of the machine. In one case blades were out for a period of several weeks without the turbine having been opened up for inspection or otherwise given more than ordinary attention. Furthermore, the effect on the capacity of the turbine is usually not felt except, of course, when the machine is operating near the limit of its capacity, which is rarely the case. As the Parsons type of turbine is a balanced machine, the rotor is always in equilibrium, the internal pressures adjusting themselves automatically, which makes

it possible to run with some blades out. The usual practice in cases of blading trouble is to temporarily remove the injured material, replace the cover and put the machine back into service until such time as repairs can conveniently be made, which is usually at night. If the work cannot be completed at one time, the machine is again assembled and continued in service until a further opportunity is available to work on it. These conditions are evidently not so "disastrous" as inexperienced opinion might lead one to think.

There is at the present time a prevalent and most unfortunate tendency to make much capital out of small troubles, and the length to which enemies of the steam turbine have gone to expose some little failing, easily corrected, is truly remarkable and often ludicrous. In instances of this kind the broadest possible view must be taken to avoid attaching undue importance to unimportant things; and the technical press can in no more effective manner demonstrate its beneficial powers than by rigorously sifting all reports savoring of undue pessimism.

Reverting again to your article, you mention the effect of vacuum in inducing heavy stresses upon the turbine casing. Now it is evident that the stresses upon a turbine casing from atmospheric pressure are quite balanced in all directions with the exception of the net area of the exhaust passages to the condenser. But the resultant downward pull is taken up directly by the turbine pedestal in either of several ways; in one, the rear footing of the turbine casing is made integral with the exhaust passage so that the excess pull exerted upon the casing is transmitted to the foundation through the rigid metallic structure at the exhaust end; in another construction the rear turbine footing is carried up as far as the main horizontal flange on the turbine casing and quite independent of the exhaust nozzle. This results in the excess pull due to vacuum being transmitted still more directly to the foundation.

As to the effect of the condenser weight, it is a more important matter to provide for variable expansion of the exhaust nozzle and connecting piping when operating on different vacua and for the possible settling of the condenser foundation. In numerous instances this has occurred, resulting in undue stress upon the turbine casing. The obvious remedy is a corrugated copper expansion joint, and on all but very large sizes of steam turbines, it is the customary practice to supply these expansion joints. It is well to remember that an installation when it is first erected may be most accurately attuned in all its parts, but how few installations of this character are gone over semi-annually, or even annually, for the purpose of checking adjustment and alignments to determine whether foundations have settled equally. Heavy stresses, often of dangerous proportions, may have developed in the interim, without giving the least external evidence.

East Pittsburg, Pa. J. R. BIBBINS.

* * *

THE A. L. A. M. STANDARD SCREWS AND NUTS.

The Association of Licensed Automobile Manufacturers some little time ago appointed a committee to investigate the subject of standard screws and nuts. These manufacturers have found, as have some other makers of high-grade machinery, that the United States or Sellers standard threads give pitches somewhat coarser than are desirable. Finer pitches have therefore been employed, each concern fixing a standard of its own. The resulting confusion has been a great annoyance to dealers, repair men, and the makers themselves, and it was to remedy this condition that the committee was appointed. Their report (of which the essential features are given in the supplement accompanying this issue of MACHINERY) has just been made public.

The shape of the thread is still that of the United States standard with straight V sides at an angle of 60 degrees, the top being flatted to one-eighth of the pitch and the bottom filled in by a like amount. The number of threads per inch has been made approximately half as many again, and the dimensions of the "hex-headed" nut, and head of bolt or "screw," as the report prefers to call it, have been made considerably smaller. The thickness of the head has also been decreased in both the case of the nut and the screw head. It has been definitely determined by experiment, however, that this thickness is amply large enough to compel the bolt or screw to fail by rupture in tension through the root of the thread just under the nut, the samples tried in no case failing by shearing of the threads, a condition which is, of course, as it should be.

A better material than that ordinarily used for screws is deemed necessary. The selection of a better material depends to a considerable extent upon the possibility of commercially machining it in screw machines, and such material has been found in several qualities of steel, having a tensile strength of not less than 100,000 pounds per square inch, and an elastic limit of 60,000 pounds per square inch, as compared with 50,000 or 60,000 pounds per square inch tensile strength and 35,000 pounds per square inch elastic limit now in common use. This material is also very much tougher, being lower in impurities and showing a very fine fracture, characteristic of a tough steel. As regards the destructive tests of tensile and shearing strength above mentioned, they were made both with ordinary material and with the material it is proposed to use for automobile work. The results were the same in both cases; that is, the screw broke at the base of the thread inside the nut.

The Association of Licensed Automobile Manufacturers, in the circular letter sent out with the report, say: "It is nothing revolutionary in any sense of the word, but, on the contrary, it conforms to the general practice of many machine tool and automobile builders. Like any new standard, it cannot be hoped that it will be adopted immediately or universally, but it is believed that it will gradually creep into use. As time goes on, it is probable that these screws will be found in stock just as the ordinary United States standard is now found. This cannot be done immediately; it must be accomplished by merit; that is, merit in this standard."

* * *

GOVERNMENT SUPERVISION OF SMALL DISTILLERIES IN GERMANY.

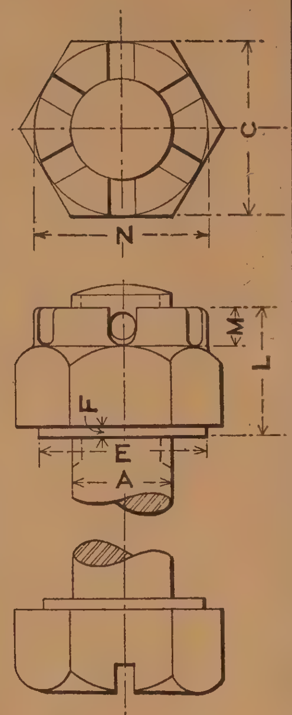
A consular report from Germany describes the method used by the German government in supervising the manufacture of denatured alcohol. There are some 70,000 farm distilleries in Germany and the problem of the government in supervising this immense number of small establishments would be a serious one if the same methods were followed that are used in the larger establishments. This is not done, however. The stills have to be made in a certain way, which includes a tank that can be locked with a government lock and sealed with a government seal. The small farm distilleries operate in the winter when the farmer has leisure to do something else than straight farm work. The farmer has to give the government thirty days' notice as to the time he wants to begin to operate his still. Some time during the thirty days an inspector comes along and looks the still over to see that it is clean, etc., and then he locks and seals the tank, after which the still is ready for the farmer. He may go ahead and distill until the tank is full. Then he informs the person who is to buy the alcohol from him, after which he notifies the government, and an inspector comes and removes the seal, measures the contents of the tank, and collects the revenue. If the farmer wants to denature the alcohol on the spot he can do so in the presence of an inspector, when the amount of the tax will be returned to him. But generally the farmers sell through the great central selling agencies, which denature at a central point and in large quantities, and collect the rebate from the government in considerable sums.

* * *

The year ending August 31, 1906, has been one of remarkable growth in the railroad department of the Young Men's Christian Association. Sixteen new railroad association buildings have been opened and ten other new associations have been organized, two of them among street railway men, making a total of 225. The membership is over 81,000 and there are now 149 buildings owned and occupied having a total valuation of $2,601,350. In addition sixteen other buildings are now being constructed at a cost of $538,000, and these when completed will make 165 buildings with a total valuation of $3,139,350.

THE A. L. A. M. STANDARD SCREWS AND NUTS.—I.

DIMENSIONS OF CASTLE NUTS

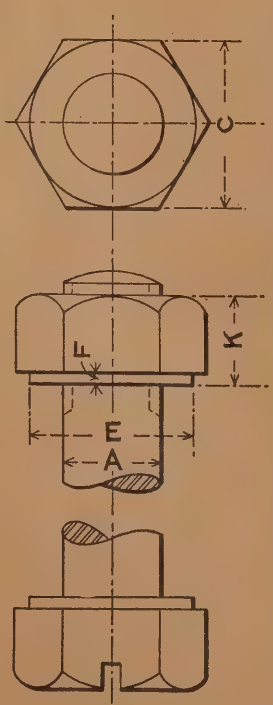


Screw Diameter	Diameter of Nut across Flats of Hex.	Diameter of Facing	Depth of Facing	Total thickness of Nut	Height of Castle	Diameter of Castle	Number of Slots in Castle	Depth of Slots in Castle (to round bottom)	Diameter of Cotter Pin used	Width of Slot in Castle
A	C	E	F	L	M	N				
1/4	3/8	3/8	1/64	9/32	3/32	3/8	6	3/32	1/16	5/64
5/16	1/2	1/2	1/64	21/64	3/32	1/2	6	3/32	1/16	5/64
3/8	9/16	9/16	1/64	13/32	1/8	9/16	6	1/8	3/32	1/8
7/16	11/16	11/16	1/64	29/64	1/8	11/16	6	1/8	3/32	1/8
1/2	3/4	3/4	1/64	9/16	3/16	3/4	6	3/16	3/32	1/8
9/16	7/8	7/8	1/64	39/64	3/16	7/8	6	3/16	1/8	5/32
5/8	15/16	15/16	1/64	23/32	1/4	15/16	6	1/4	1/8	5/32
11/16	1	1	1/64	49/64	1/4	1	6	1/4	1/8	5/32
3/4	1 1/8	1 1/8	1/64	13/16	1/4	1 1/8	6	1/4	1/8	5/32
7/8	1 1/4	1 1/4	1/64	29/32	1/4	1 1/4	6	1/4	1/8	5/32
1	1 7/16	1 7/16	1/64	1	1/4	1 7/16	6	1/4	1/8	5/32

MACHINERY, N.Y.

THE A. L. A. M. STANDARD SCREWS AND NUTS.—II.

DIMENSIONS OF PLAIN NUTS



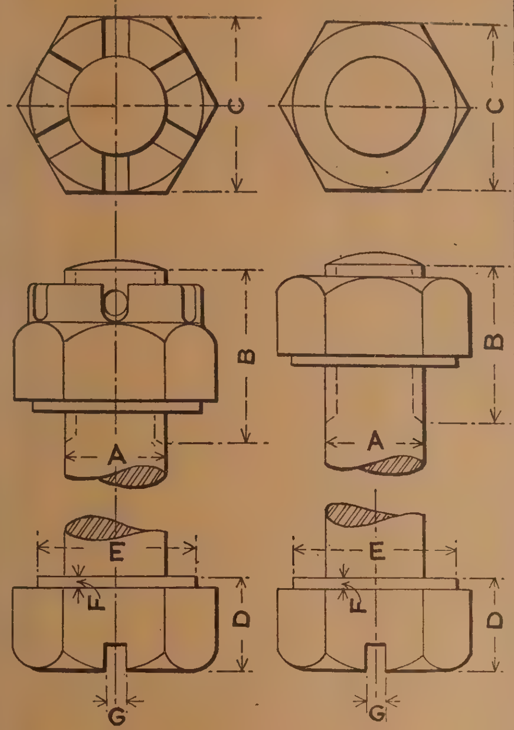
Screw Diameter	Diameter across Flats	Diameter of Facing	Depth of Facing	Thickness of Nut
A	C	E	F	K
1/4	3/8	3/8	1/64	7/32
5/16	1/2	1/2	1/64	17/64
3/8	9/16	9/16	1/64	21/64
7/16	11/16	11/16	1/64	3/8
1/2	3/4	3/4	1/64	7/16
9/16	7/8	7/8	1/64	31/64
5/8	15/16	15/16	1/64	35/64
11/16	1	1	1/64	19/32
3/4	1 1/8	1 1/8	1/64	21/32
7/8	1 1/4	1 1/4	1/64	49/64
1	1 7/16	1 7/16	1/64	7/8

MACHINERY, N.Y.

THE A. L. A. M. STANDARD SCREWS AND NUTS.—III.

DIMENSIONS OF SCREWS

Form of Thread, U. S. Standard.



Diameter	Pitch	Length of Threaded portion	Diameter of Head across Flats	Thickness of Head	Diameter of Facing under Head	Depth of Facing under Head	Width of Slot in Head	Depth of Slot in Head	Diameter of Cotter Pin Hole
A		B	C	D	E	F	G		
1/4	28	3/8	3/8	3/16	3/8	1/64	1/16	3/32	5/64
5/16	24	15/32	1/2	15/64	1/2	1/64	1/16	7/64	5/64
3/8	24	9/16	9/16	9/32	9/16	1/64	3/32	1/8	1/8
7/16	20	21/32	11/16	21/64	11/16	1/64	3/32	1/8	1/8
1/2	20	3/4	3/4	3/8	3/4	1/64	3/32	1/8	1/8
9/16	18	27/32	7/8	27/64	7/8	1/64	3/32	1/8	5/32
5/8	18	15/16	15/16	15/32	15/16	1/64	3/32	1/8	5/32
11/16	16	1 1/32	1	33/64	1	1/64	3/32	1/8	5/32
3/4	16	1 1/8	1 1/8	9/16	1 1/8	1/64	3/32	1/8	5/32
7/8	14	1 5/16	1 1/4	21/32	1 1/4	1/64	3/32	1/8	5/32
1	14	1 1/2	1 7/16	3/4	1 7/16	1/64	3/32	1/8	5/32

MACHINERY, N.Y.

THE A. L. A. M. STANDARD SCREWS AND NUTS.—IV.

NOTES ON MATERIAL, FINISH, AND DIMENSIONS

1- Material

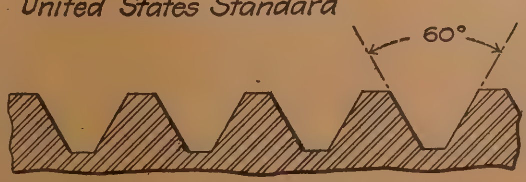
For all screws and nuts - steel,
Tensile strength, not less than 100,000 lbs. per square inch;
Elastic limit, not less than 60,000 lbs. per square inch.

2- Dimensions

All dimensions in inches.
Length of threaded portion: 1½ times body diameter.

3- Form of Thread

United States Standard



Flat top and bottom, one eighth of the pitch.

4- Finish

Screw heads shall be flat chamfered.
Plain nuts shall be flat chamfered.
Castle nuts shall be chamfered.
What is understood by screw makers as "semi-finish" shall be the finish for all heads and nuts.
Screws are to be left soft. Screw heads are to be left soft The plain nuts are to be left soft. The castle nuts are to be case-hardened

5-Tolerance

The body diameter of the screw shall be one-thousandth (.001") inch less than the nominal diameter, with a plus tolerance of zero and a minus tolerance of two-thousandths (.002") inch.

The nuts shall be a good fit, without perceptible shake

The clearance between tops of threads and bottom of threads in nuts shall be that existing in the present practice of machine screw makers; that is, the tap shall be between two-thousandths (.002") inch and three-thousandths (.003") inch large.

MACHINERY, N.Y.

NEW PLANT OF THE BOSTON GEAR WORKS.

The Boston Gear Works have erected a new shop for the production of gears at Norfolk Downs, Mass., a suburb of Quincy, six miles out from Boston on the Plymouth division of the New York, New Haven & Hartford R. R. The company, of which Mr. Frank Burgess is the animating spirit, has been located for the past seven years at 152 Purchase St., Boston, Mass., and they will still maintain the Boston office at 102 High St.

The main building, Fig. 8, is approximately square, being about 100 feet wide by 125 feet long, one story high with saw-tooth roof. There is a second story over the middle portion of the shop which is given up to the drafting room and offices for the clerical force. The building is exceptionally well lighted by large windows in the sides and the windows in the saw teeth of the roof, which face the north. The sides of the shop are covered with galvanized-iron clapboards.

The management of the shop consists of a central expert authority which controls the different departments through experienced men known as "jobbers." These men issue the orders for work to the shop directly, each handling those orders for which he is best fitted by experience and training. The machines are in charge of foremen who bear the same relation to the superintendent that the jobbers do to the central head before mentioned, and these follow personally the different jobs entrusted to them.

The worm gear department is equipped for the production of all classes of this style of gearing, many of the machines being of special design built by the firm for their own use. Hobs used for cutting teeth of worm gears are made in the toolmaking department and general use is made of high-speed steel for this work. This department is illustrated in Fig. 1.

The spiral gear and worm department, illustrated in Fig. 2, is equipped with a full line of machinery, and a specialty is

Fig. 1. Worm and Worm Gear Department.

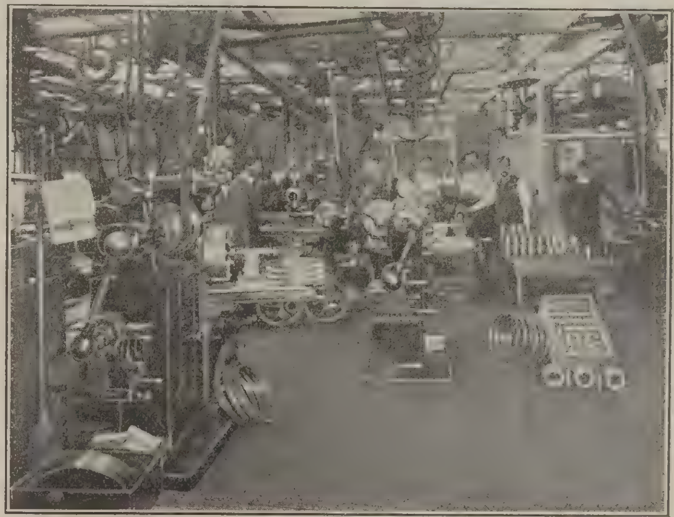


Fig. 2. Special Machinery for Cutting Helical Gears.

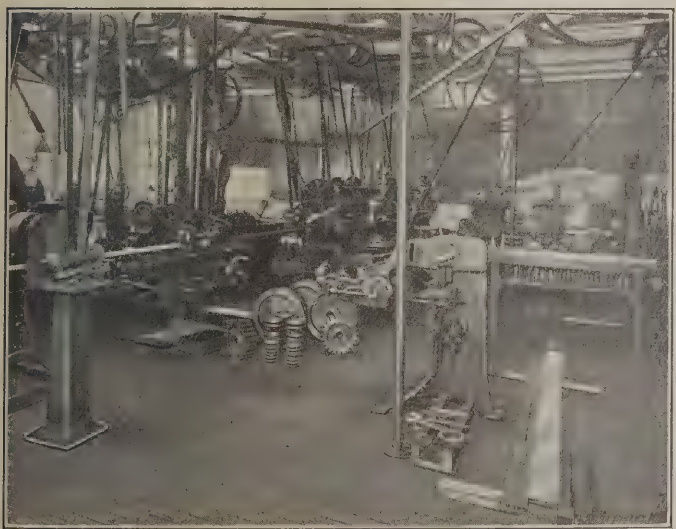


Fig. 3. Gear and Rack Department for Planing and Generating Spur Gear Teeth.

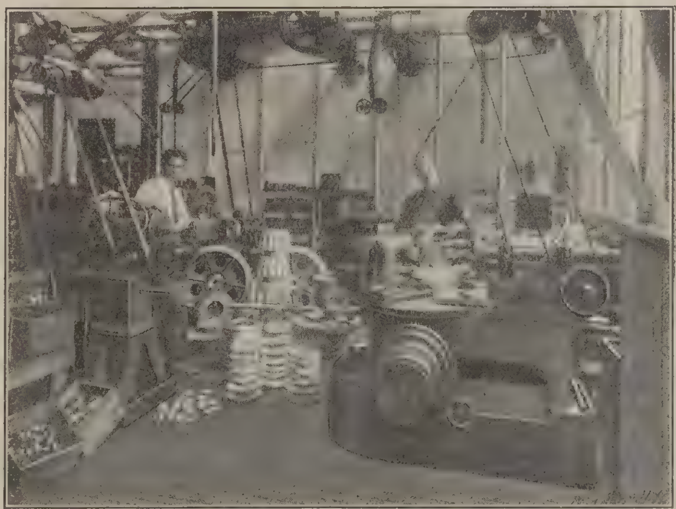


Fig. 4. Automatic Bevel Gear Planing Section.

made of all forms of spiral and helical spur gears and worms. This style of gearing is made to run at any required angle of shafts or with parallel shafts and at any speed ratio.

The spur gear and rack department shown in Fig. 3 also embraces the cutting of intermittent, elliptic, skew bevel and internal gears, ratchets, clutches, crown wheels, etc. At the extreme right in Fig. 3 is shown a spur gear machine with micrometer adjustment which gives the required center distance within 0.0005 inch of accuracy. This department is, of course, the largest cutting department in the factory. It is equipped with modern automatic machinery for generating the teeth of racks and spur and internal gears theoretically correct, these machines being of the Fellows type.

The bevel gear department shown in Fig. 4 is equipped

The motive power of the shop consists of two Hornsby-Ackroyd oil engines of 25 H.P. each. These are ordinarily run together, but may be run separately when occasion requires. A pump circulates hot water through the shop for toilet and cleaning purposes. Cold water at 80 pounds pressure is supplied by the Quincy Water Works.

The shop is classified into departments as follows: Worm gear department; spiral gear and worm department; spur gear and rack department; bevel gear department; toolmaking department; screw machine and automatic machine department; lathe department; brass model gear department; automobile department; polishing department; stock department; case-hardening department; testing department, and pattern department.

with Gleason gear planers and other machines for the accurate production of bevel and miter gears. A specialty is made in this department of automobile driving and differential gears and large contracts are made with various automobile manufacturers for gearing which they are not equipped for producing in their own shops.

The making of cutters, hobs, tools, and cutting of cams and repairing and building of machinery is done in the toolmaking department. All special tools, jigs, gages, etc., are also kept in this department.

Fig. 5 illustrates the screw machine department, which is equipped in the regular manner with turret lathes and automatic screw machines, and besides with a number of special attachments built by the firm for work of special character.

The brass model gear department is devoting itself to the manufacture of small work, such as pinion wire, clockwheels,

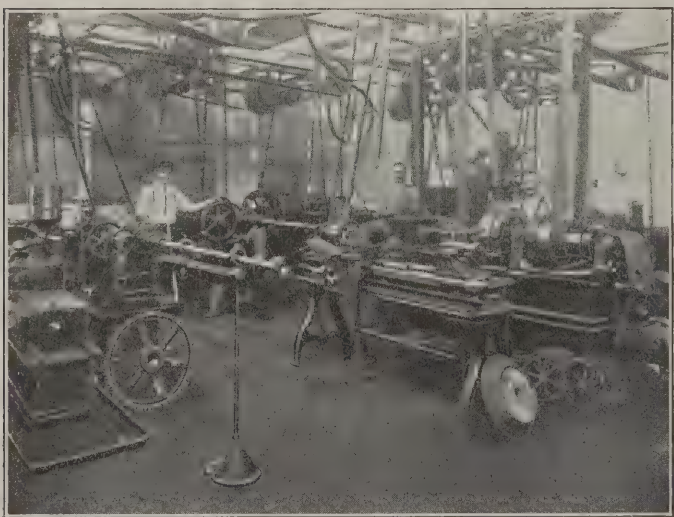


Fig. 5. Turret and Automatic Screw Machine Department

ratchet wheels, etc., and in fact contains machinery of all descriptions to be found in the other departments, except that these machines are designed for very small work. Orders in this section frequently run up to 25,000 pieces.

The automobile department, illustrated in Fig. 6, has derived its name from the fact that the "safety steering device," manufactured by the firm, is made principally in this department. This department also comprises the general machine department, where tools of a general character, such as engine lathes, etc., are placed.

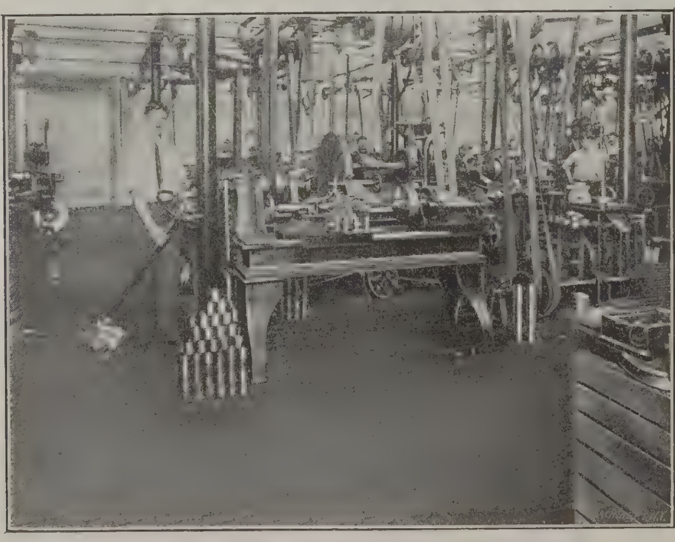


Fig. 6. General Machine and "Automobile" Department.

Fig. 7 shows the testing department, located in the center of the shop. This department stands under the direct supervision of the superintendent, and is conducted by the foremen of the various departments. It is well equipped for testing the products of the firm to very close limits, a number of devices having been designed particularly for this purpose.

The cost system of the shop is organized with a view of giving at once and in detail the cost of any job passing through the works. Accurate records of the time used on each job are turned in every day by the respective foremen.

The comfort and requirements of the employes has been taken in due consideration. The factory is provided with a

Fig. 7. View showing Testing Department and Tool Stock Room; Dey Time Clock at the Right.

lecture room, and with a large wash room with hot and cold water and individual lockers, each having its own key. The factory is, in fact, perfectly modern in its equipment in all respects, and very few things indeed seem to have been overlooked in its planning and construction.

* * *

ELECTRICAL STEEL MELTING FURNACE.

The primary difficulty with electrical steel melting has been that the use of electrodes has changed the composition of the metal. This difficulty seems to have been overcome in the new electrical furnace installed by Henry Disston & Sons at their Tacony works near Philadelphia, Pa. Briefly, the furnace is an electric transformer in which the metal to be

Fig. 8. General View of Boston Gear Works.

melted is arranged in a closed ring form, the crucible being in the shape of an annular ring. The crucible encircles the central portion of a laminated iron core which extends across the top, two sides and bottom of the crucible, constituting a closed magnetic circuit. An alternating current of low amperage is passed through a conductor surrounding the central portion of the iron core. With each alternation of current in this primary conductor a current of electricity is induced in the metal placed in the annular cavity of the crucible, by means of which the melting of the metal is effected. There is no contact between the primary and secondary circuits and there are no electrodes, consequently no alteration occurs in the metal operated upon. The steel is melted by the heat developed within its own mass by the passage of the induced current. The tests thus far made prove conclusively that the electrically melted steel fully meets the requirements of the highest standard of quality. It has been subjected to the usual chemical and physical tests and has been used in the manufacture of several of the products of the company. As far as the quality of the product is concerned it may also be noted that since the metal is melted in the absence of fuel gas it yields a very dense and fine-grained casting and its final composition is dependent solely upon the predetermined composition of the material.

MILLING OPERATIONS.

JOHN EDGAR.

In the editorial "The Value of the Camera as an Instructor" in the September issue, the editor in commenting on the article by Mr. Fairfield on "Planing a Small Machine Part," holds out the view that the milling machine could not perform the work in a very successful manner as compared with the planer. This of course leaves room for an argument, and being of a "butt in" nature, I feel that it is up to me to keep my record and try to show that the milling machine can handle the particular piece of work successfully in comparison with the planer, both in regard to finish and accuracy. It is mainly on just such work as this that the milling machine has proven its great advantage in the economical production of machine work. Why the editor singled out this particular job is beyond my comprehension.

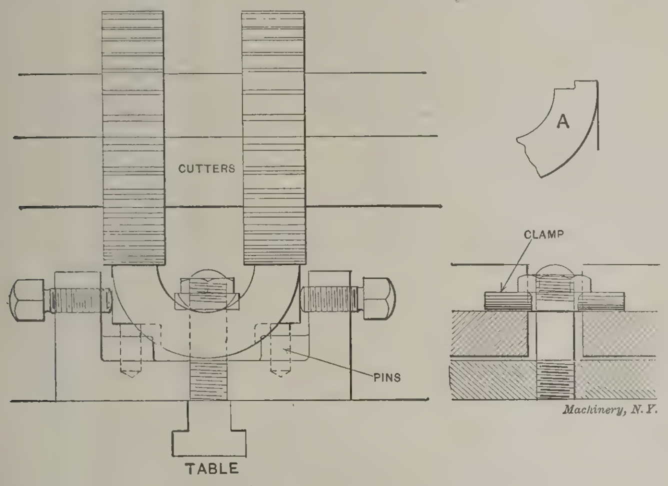


Fig. 1. Milling the Cap.

Taking the cap first we may hold it in a manner similar to that shown by Mr. Fairfield in his photographs and the operation may be performed on almost any style of milling machine. Take the plain miller, use two narrow plain cutters and hold the work in the vise; one or two cuts would be taken over the surface to be machined, using fast feeds with considerable depth of cut for the first cut, and a finer feed and higher speed for the final or finishing cut. A better surface cannot be obtained expending the same amount of time on a planer. The cutters must be in excellent condition in order to obtain good results, but the same applies to the planer tools as well. If we are manufacturing a large number of these pieces it will pay to make special fixtures for holding them, arranging them so that the extreme length of the table feed or travel may be used. We may arrange to take one or more rows of the castings side by side, depending on the size of the miller. This cap is a piece exceedingly easy to hold in a fixture such as shown in Fig. 1. The cap will be seen to be resting on pins where the bosses for the cap bolts come, this making a convenient and reliable foundation. The cap is held sideways by the setscrews on either side and is held down on the pins by the clamp shown in the sectional view. The drawing explains itself, so that but few words are necessary in connection therewith.

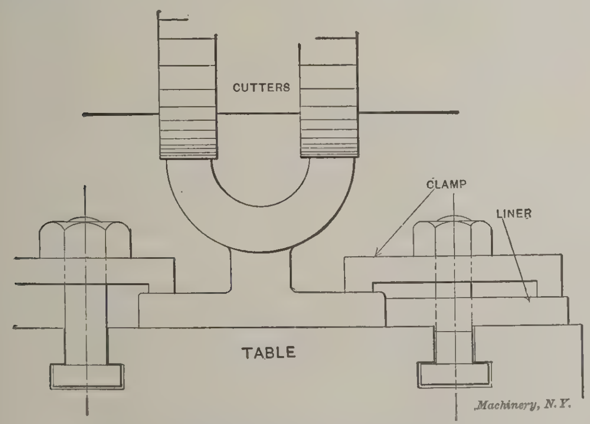


Fig. 2. Milling the Seat for the Cap on the Base.

In the holding of work on the milling machine table or in supplementary fixtures it seems to have become the idea that it is necessary to bolt it down with all the force that it is possible to use without stripping the thread on the bolts. So much strain is not necessary, serving as it does only to distort the table, making it run hard and eventually producing a permanent set which gives the working surface an untrue face. This straining of the binder bolts also wedges the T-slots out of shape, peening the metal above the T so as to project above the rest of the surface. An examination of the machine in operation will show that in 90 per cent of the work done the force or pressure of the cut is symmetrical and has but little effect on the work, all the holding required being merely that necessary to keep it from sliding either along in front of the cutter or sideways. This is accomplished by bunters and toe clamps. Of course it is necessary that the work be held down on the platen, but very little power is necessary in doing so. Had the cap been made with the matched fit shown at A instead of the straight fit, the advantage of milling over planing would have been much more apparent, as gang cutters would have finished the work at one setting, while the planer would have required at least two. But the real gain would be in obtaining interchangeable work which can be obtained on the planer only at the expense of considerable time and trouble, but which is a matter of course on the miller.

In performing the corresponding operation on the base casting we have the advantage of the broad base and the projecting surfaces for clamping which make it an easy matter to set and hold the work. The same that has been said regarding the operations on the cap may be applied to the base. Fig. 2 shows how this piece would be held. The clamps hold down the piece, while the piece is blocked up against a liner to insure a setting parallel with the travel of the table. The row is kept from shifting endwise by using the bunters mentioned above. In machining the foot of the base piece we are confronted by a job that presents a kind of milling operation which has many little points of interest. The problem of milling comparatively broad surfaces is presented. It is an acknowledged fact that the milling of such surfaces must be accomplished by cutters that are so constructed that the chip is broken up into short cuts, giving the operation the advantage of the single pointed tool in the question of power required, and truth of surface obtained. This is accomplished by notching the teeth of the cutter so that they may be presented to the work successively, both notches and teeth being cut spiral at right angles with each other. A surface produced by such a cutter will bear the strictest examinations as to truth without being found wanting.

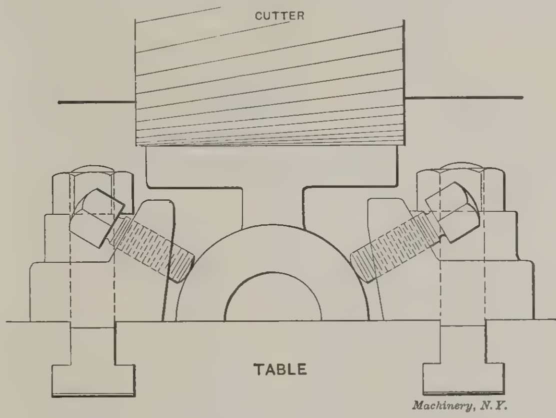


Fig. 3. Slab Milling the Lower Surface of the Base.

Fig. 3 shows one method of machining the bottom surface. In this method we use a plain milling cutter as shown, taking one or two cuts as the case may require. If very little stock has to be removed but one cut ought to be sufficient as the resulting surface will be good enough for the intended purpose. As will be seen the piece is held down and prevented from moving sideways by the screws which are tapped

through the strips bolted to the table. This makes a convenient method and one that will be found to answer the purpose very well. Another method of performing the operation is by the use of an end mill as shown in Fig. 4. This means of removing the metal is very efficient as a very true surface can be obtained with a much faster feed and deeper cut than can be done by slab-milling. The power necessary to revolve the cutter and force the feed is very much less than that used for slab-milling. While the surface may be badly marked it will yet be almost absolutely true. When the work is set up on edge as shown no trouble is encountered with the chips as is otherwise the case. We are fortunate in finding this piece to be a very easy one to provide jigs for, as it permits itself to be set in almost any position. The method used in Fig. 4 is a good one, and will be found very convenient. The top clamp is removed when the work has to be removed or placed in position. This clamp serves the double purpose of holding the work and of setting it in line, the screw being used to make any allowance for variations in the castings. When this method is chosen the machining of the bottom should be done before the cap bearing is milled as this gives a good solid setting for the latter operation. A great many operations may be accomplished by this latter method which are now milled with plain cutters. The action of the cutter in this operation closely resembles that of the

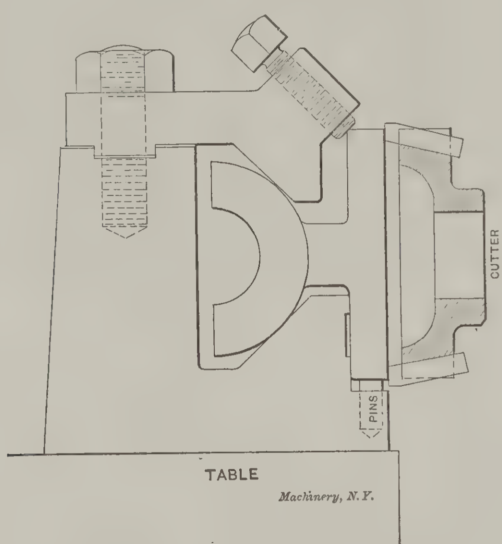


Fig. 4. Another Method of Milling the Lower Surface of the Base.

single pointed tool and has all the advantages that are claimed for this tool, but very few of the disadvantages, and it is a multiple cutter which means greater output.

The milling machine has made great strides in the last twenty years, but we may safely look ahead in the future for the real growth of this method of finishing machine details.

The cuts shown leave considerable to the imagination, as they show but an end view of the work. This is done because the same method may be used to advantage in holding one or a dozen pieces. Elaboration on the above does not seem necessary, since the principle is shown; and since it represents no particular case no figures are given.

The real purpose of the above is to let off a little pressure caused by the editor's comments, and as we milling machine men are very jealous of the machine's record we must always be at hand to contradict any remarks that may serve to cast reflections on its ability to "eat iron" *economically*.

* * *

An illustration of the cost of unwinding red-tape in the conduct of municipal affairs is that of New York City recently in making a small payment. An order directing the payment of five cents to a dealer for making a small blueprint from a tracing passed through the hands of eighteen city officers and cost the city $5, it was estimated, for the transaction. When municipal affairs are conducted on common-sense business principles there will be some hope of cities conducting their public utilities profitably—profitably in the sense of giving better service for less money than is now the rule.

SPRING SCREW THREADING DIES—A CRITICISM OF A CRITICISM.

A. L. VALENTINE.

In the October issue of MACHINERY appeared an article about spring screw threading dies, or rather a criticism upon an article about spring screw threading dies written by a contributor to MACHINERY in the August issue. This criticism led the writer to study more closely the points brought forth in the article written by Mr. Oberg in the August issue, than was done in the first place, and after having made a careful comparison between the different views brought forth in the articles of the two contributors, the writer could not refrain from "butting in," as it occurred to him that the criticism

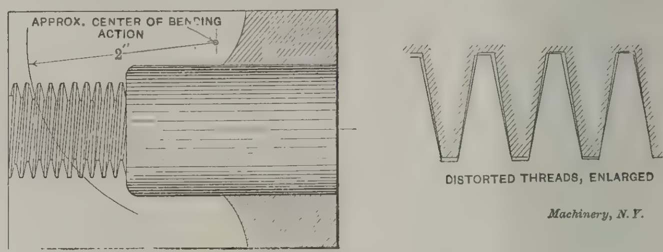


Fig. 1. Spring Screw Die with Special Threads, and Threads Distorted by Common Adjusting Method.

written by Mr. Johnson has several points in itself that should not pass by uncriticised. The need of this will be very apparent to any of the readers if they care to study the subject in question a little deeper, and not consider it from so purely a theoretical or so purely a practical side as was done by the two contributors above mentioned. The subject is one of wide importance and, as Mr. Oberg correctly mentions, there is so little said about these tools in the mechanical periodicals that it would be a pity to lay the subject on the "shelf" so soon. As the writer has had a good deal of experience especially in the making and testing of these tools, a few remarks from him might be of interest as well as of benefit to some of the readers of MACHINERY.

What most prominently attracted the attention of the writer in Mr. Johnson's criticism on Mr. Oberg's article, was the failure of the former to recognize any of the very valuable theoretical facts, set forth in Mr. Oberg's article, as being of any value, when it came to considering the subject from a practical standpoint; furthermore that it would be next to impossible to manufacture these tools as outlined in Mr. Oberg's article, as well on account of the difficulties encountered when making them as the impossibility to make the manufacture of them a financial success. Now, before going any deeper into the subject let me assure the readers of MACHINERY that *nothing was ever practically correct if it was theoretically wrong*, nor has it, in hardly any case, been impossible to devise ways and means of accomplishing anything, if this anything was actually desirable. It may, of course, not be possible without devising something new or something entirely different from old established ways, but is it not rather worth while going to this trouble and be nearly or perfectly correct than to be sure to be wrong, as Mr. Johnson frankly admits in his article that he is, as regards the size and the form of the thread in the spring screw threading dies he is making or in dies made as outlined by him in his article? He is indeed lucky not to have had to make these dies with much sharper angle of thread than 60 degrees, which can be clearly seen from his article and the way he is making his dies, that he has not. For if he had, he would certainly have found Mr. Oberg's way of making them not only practical but he would find it absolutely impossible to produce even a "nearly correct" threaded piece with a spring screw threading die made as outlined by him in his criticism. Let us as-

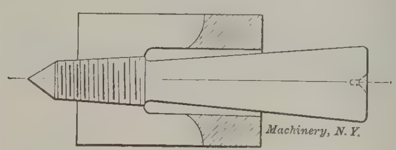


Fig. 2. Spring Screw Die Mounted on Threaded Arbor for Grinding.

sume, for example, that the writer would have made a number of special spring screw threading dies, which the firm he is working for had an order for a short while ago, as outlined by Mr. Johnson. The dies were 2-inch outside diameter and 3½ inches long; the diameter of the piece to be threaded was one inch, the inclusive angle of the thread was 20 degrees; 8 threads per inch, and the depth of thread was 3/16 (see Fig. 1, where the die is shown and where the thread is shown in enlarged scale with the correct angle and with the angle it would have had, had the die been closed to size after having been made as outlined in Mr. Johnson's article). Dies of above description ought to have been hobbed out about 0.015 inch over size, as they were to be used on brass, and in a die with a form of thread with the angle mentioned above it would not be sufficient to close it down to cut to size, it would have to be closed down to cut a certain amount undersize (thus still more increasing the error in the angle of the thread) to allow the piece threaded with the die to go into the hole tapped out with a tap having the correct angle in the thread, and finally after having adjusted the die down to cut small enough, imagine what a fine fit this threaded piece would have had in the tapped hole. It is admitted that these dies were out of the ordinary, and some one might even say that the rule should be dealt with and not the exception, but the example was given to show that theory will always work and produce correct results where practice fails to do so.

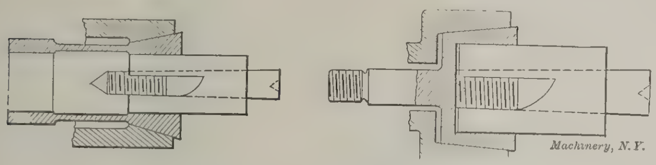


Fig. 3. Grinding the Outside of Spring Screw Dies.

Now let us look into the difficulties encountered when making a spring screw threading die as outlined by Mr. Oberg, and see if these difficulties are unconquerable and if they are real. The worst difficulty seems to be the grinding of the outside of the die true with the thread after hardening. Now if it should be utterly impossible to grind the outside of the die true with the thread after hardening in some cases why should we omit grinding the outside of all dies for this reason? No one can fail to see the advantage, I am sure, of having the part of the die by which it is held (the outside) ground true with the part doing the cutting (the thread). It may be difficult to grind some sizes of dies, but certainly not impossible even under manufacturing conditions as Mr. Johnson thinks it is. The advantages gained would, I think, be fully worth the cost of conquering the difficulties encountered, even in grinding one of these "impossible" dies. When grinding the outside of a die true with the thread after hardening, the writer would suggest holding the die, as outlined in Mr. Oberg's article, on a threaded arbor (Fig. 2), but not grinding the whole length of the die at once, as this would be impossible probably in some cases as Mr. Johnson says, but it should be ground for a length corresponding to the length of the thread in the die. The operator will find no difficulty in grinding up on the die for that length as the arbor and the die for that distance are practically one solid piece and are well supported by the centers of the arbor, which of course should not project outside of the die more than necessary. When this is done the die should be taken—with the arbor still in place in the die—and put into a machine equipped with a drawback mechanism and a spring collet or step chuck (Fig. 3). The die is then, of course, held by the outside by the already ground portion of same, and the back can if necessary be supported by the center of the arbor. Anyone making a business of manufacturing spring screw threading dies would find this operation very inexpensive. There are few up-to-date grinding rooms which have not some grinder rigged up with a drawback mechanism and collets used for other purposes; however we will come to the cost later.

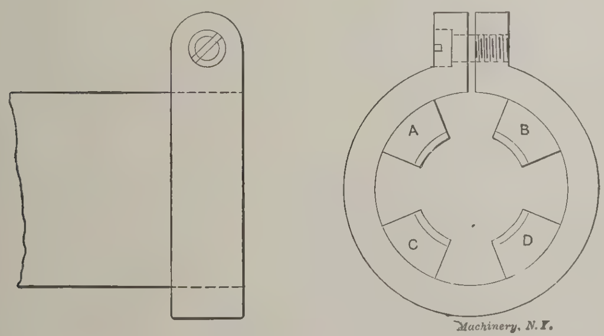


Fig. 4. Common Type of Clamp Collar.

The second difficulty encountered by Mr. Johnson in his criticism would be the closing in of the dies in hardening, if made as outlined by Mr. Oberg, viz., to be of the correct size at the point before hardening. Now Mr. Johnson himself in his article tells us of a way to harden these dies and that if the dies are hardened as outlined by him he claims they come out practically straight. His way of hardening is undoubtedly correct, and there is no danger of the prongs of the dies springing or going out of straight if hardened as outlined by him. Why can we not then harden the dies made as outlined by Mr. Oberg in this manner, and save the trouble of having them annealed and rehobbed an unlimited number of times on account of the prongs of the dies being closed in because of *improper* hardening?

Another difficulty was the problem of being able to make the "taper ring" clamp collar remain on the die in an automatic screw machine. Now, in the writer's opinion, there is no clamp collar made as yet that will excel this one, neither the commonly used one (Fig. 4) nor any of the two shown in Mr. Johnson's article. If the difficulty of keeping this "taper ring" clamp collar on the die in an automatic screw machine has been solved in some establishment visited by Mr. Johnson by means of holding it back on the die with a string that is no reason why this clamp collar is of no use; that merely shows that the establishment in question was lacking in mechanical supervision. While the writer can plainly see the points of superiority of the clamp collar shown to the left in Fig. 5 over the one shown in Fig. 4, he fails to see any superiority of the one shown to the right in Fig. 5. It is claimed in Mr. Johnson's article that both collars shown in Fig. 5 are superior to the one most commonly used (Fig. 4).

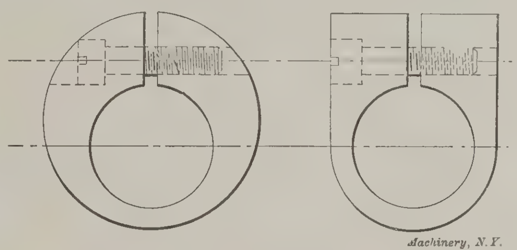


Fig. 5. Special Types of Clamp Collars.

Now as to the difficulties encountered in making the business of manufacturing spring screw threading dies financially successful, there is no doubt that the increase in the number of dies sold (on account of the reputation of furnishing the customers with perfect dies) at a smaller profit, will fully outweigh the smaller number of dies sold before at a larger profit. Furthermore, if we look into this extra expense a little more closely, we will find that it is a comparatively small item. A die not ground on the outside after hardening is made from either drawn wire of the correct required size or made from rough stock, which before being made into die blanks had to be turned and ground. A die ground on the outside after hardening is made from rough stock, rough turned and ready for grinding after hardening. Right here we have a saving of either the difference in price of drawn wire and rough stock or the saving of the cost of grinding the soft blanks. If we add to this saving the time saved in not having to be so extremely particular in making the tapped hole run perfectly true with the outside of the die, which we have to be if the die is not to be ground on the outside after hardening, we have quite an item to deduct from our grinding expenses after the dies are hardened. As regards the difference in the expense in making the die taps and hobs the writer can see none. The only increase the writer can see is the expense of making the arbor

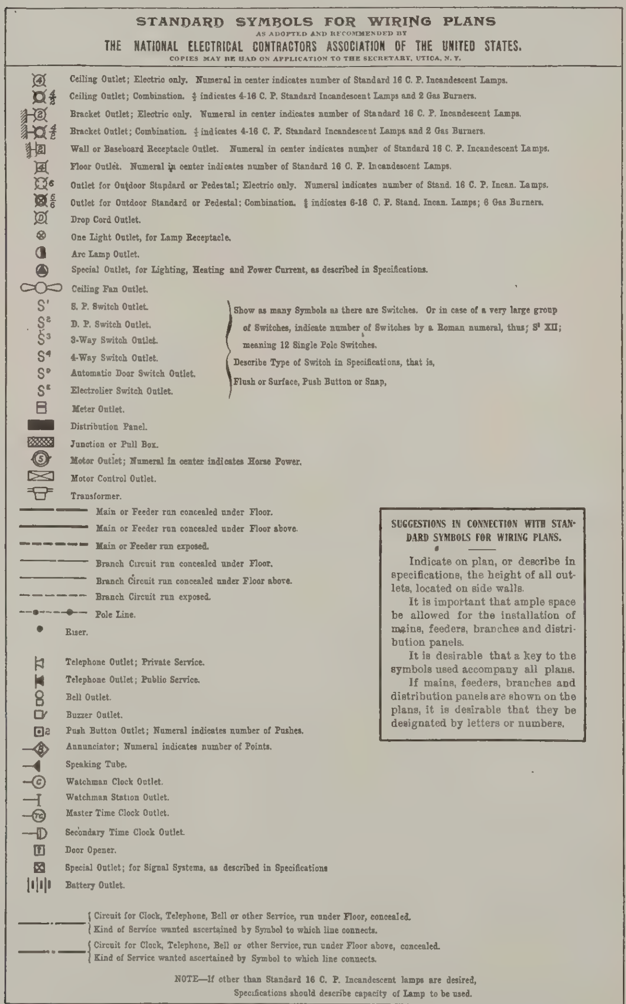
used when grinding the outside of the die, but when considering that this arbor is made exactly the same and at the same time as the hob the expense is reduced to a minimum.

It is to be hoped that the contributor of the article about spring screw threading dies in the August issue of MACHINERY will not think that the writer takes up the defense of some of the theoretical points set forth in his article, on account of thinking him unable or incapable of defending them. It is just because the writer has had the opportunity of using spring screw dies in practice and attained results which were correct in every respect. The means employed were practically the same as outlined in Mr. Oberg's article, and they were not nearly as unfeasible to use, as the latter contributor seemed to think. Just because a new or untried idea may prove itself connected with difficulties, that should be no reason for its immediate repudiation. A thorough investigation should be allowed as to whether the difficulties are real, or if the advantages gained are worth the removal of the obstacles.

* * *

STANDARD SYMBOLS FOR WIRING PLANS.

The accompanying photographic reproduction shows the standard symbols for delineation in wiring plans which were adopted by the National Electrical Contractors' Association at their Cleveland Convention, July, 1906. These symbols were adopted after a year's careful consideration and conference with leading engineers, architects, professors, government



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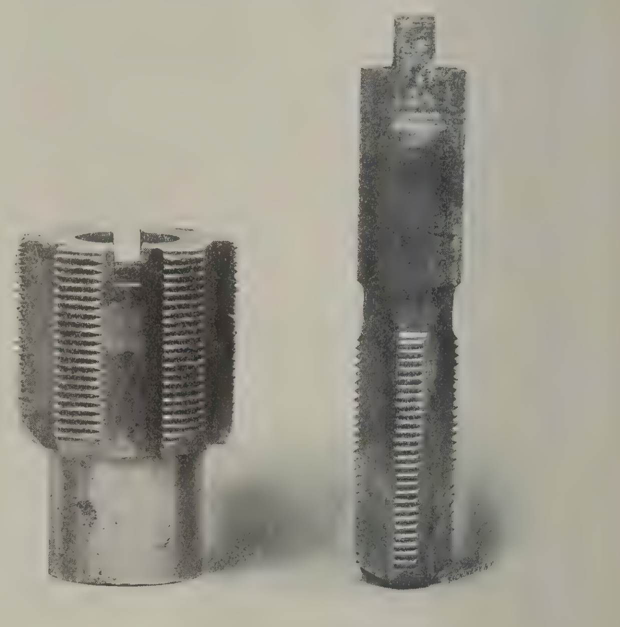
employes, editors of technical publications, etc. It is believed by the committee that they represent in convenient and readily recognized form the parts designated. The symbols and explanation shown in the reproduction are printed on cardboard, 10½ x 16 inches, and copies may be obtained upon request from the secretary, Mr. W. H. Morton, 94 Genesee St., Utica, N. Y.

* * *

Don't take a finishing cut on a broad surface of cast iron without first filing the scale on the front end all away as far down as the tool goes.

TWO TAPS WITH A GOOD ENDURANCE RECORD.

The accompanying halftone shows two taps used in the works of the Reo Motor Car Co., Lansing, Mich., which have a good record for endurance, each having tapped 10,000 holes ¾-inch deep. The larger tap is 2¼ inches diameter and the other 1 inch, and both are of the same pitch, 12 threads per inch. The length of holes tapped equals 7,500 lineal inches, or 625 feet of cast iron, and the taps are still in fairly good shape. The long endurance of these taps is attributed to the method of tempering developed by Mr. J. F. Sallows, foreman



Taps with Good Endurance Record.

blacksmith of the Reo Motor Car Co. The taps are soft enough to be machined anywhere except the teeth, and the same method is employed by him on all similar tools, only the cutting parts being made hard. Mr. Sallows' method is to temper at a low heat in cold salt water and sperm oil. We understand that his method of tempering will be fully explained in detail in a new book to be published soon by the Technical Press, of Brattleboro, Vt.

* * *

OCCASIONAL ANNEALING OF MACHINE PARTS TO PREVENT BREAKAGE.

On many machines the writer has noticed during his experience, there are frequent breakages of particular parts. It is almost periodically expected that certain parts will last just so long before they crack. In some cases this, of course, is unavoidable and occurs through excessive work on a particular part, which wears it rapidly, but where a piece breaks often with no great amount of wear on it we must look for another cause, and this will almost invariably be due to crystallization of the granular structure of the material. This crystallization of steel or iron will occur through frequent shocks, and any piece which is subjected to vibration will quickly become crystallized, and then the strain required to break the part is little greater than that required to break a section of glass of about the same dimensions.

To prevent the breakages of such parts, an excellent plan which has been found to give unfailing results is to remove from the machine such part and heat same to about 900 degrees to 1,200 degrees F. and allow same to cool in lime or in the furnace where it is heated. This is simply an annealing treatment and allows the structure of the material to assume its original condition as before being subjected to the disturbing influence.

This method has saved a considerable amount of repairing and replacement on such machines as engines, planers, trip hammers, and other machine tools where there is any shock or vibration. VIBRATION.

LETTERS UPON PRACTICAL SUBJECTS.

SIMPLE METHOD OF PROVING MULTIPLICATION.

In the August issue of MACHINERY there appeared an article which interested me on proving multiplication and addition by casting out the nines. For simple multiplication the operation may be simplified somewhat. Example as follows:

```
     31416
      7854
  --------
    125664
   157080
  251328
 219912
 ---------
 246741264
```

Add the digits in the multiplicand, $3+1+4+1+6=15$, and $5+1=6$. Add the digits in the multiplier, $7+8+5+4=24$, and $2+4=6$. 6 times $6=36$ and $6+3=9$. Add the digits in the product, $2+4+6+7+4+1+2+6+4=36$, and $6+3=9$. That is, add the digits in the multiplicand and multiplier until we obtain a result of one figure, multiply these together and add again until the result is expressed in one figure. The sum of the digits in the product, proceeding in the same way, should be the same.

This method is a very rapid one, as even a long multiplication may be quickly checked by a mental calculation. However, it should be noted that neither this, nor casting out the nines, is an absolute proof. A failure of either of these tests shows the example to be wrong, but if the digits anywhere are simply interchanged the answer may be incorrect and yet according to the above test be right. This, however, would seldom happen.

KENNETH G. SMITH.

Wellsville, N. Y.

A GRINDING FIXTURE AND ITS WORK.

The line cuts and halftone illustrate a very fast and successful little fixture for grinding a radius on a segment gear blank. The work is previously finished to the dimensions given in Fig. 1, the dotted lines showing the stock left for

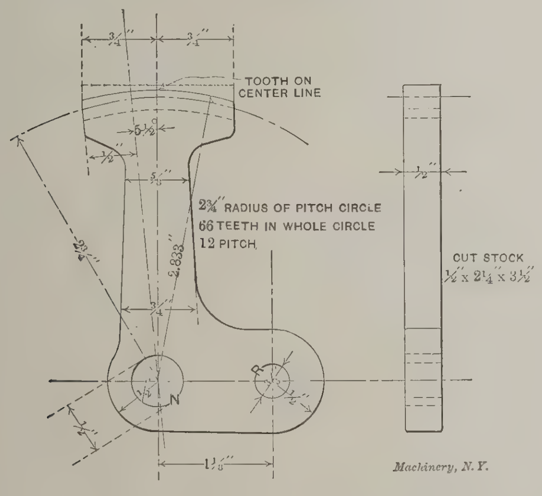


Fig. 1. Gear Segment to be Ground.

grinding the radius of the outside diameter of the segment blank. The grinding was done on a No. 3 Universal Landis grinding machine, the machine, fixture and a pile of rough and finished work being illustrated in Fig. 2. An assembled view of the fixture is illustrated in the drawing Fig. 3.

The fixture comprises a base suitably arranged for clamping to the swivel table of the grinding machine; this base carries at the height of the center of the grinding wheel a pin or fulcrum on which is pivoted a work-carrying arm which may be seen in Fig. 3. This arm is provided with a slot of a suitable width to receive the work, which is first slipped on to a projection of the fulcrum and then swung down into the slot where it is clamped by means of a thumbscrew, a locat-

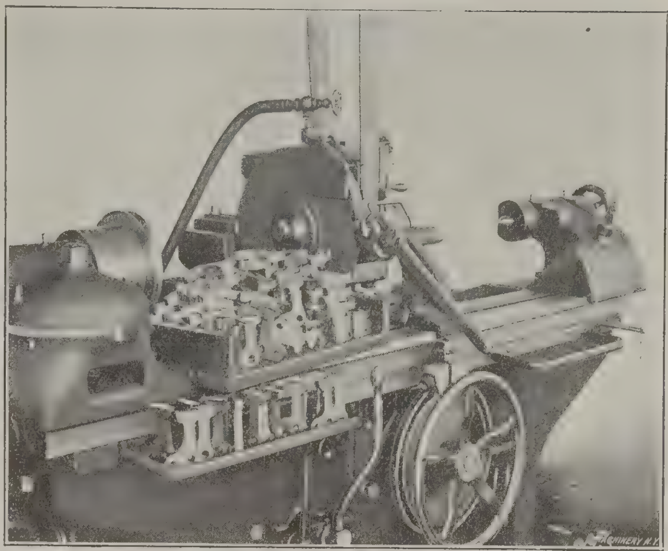


Fig. 2. The Fixture, Work and Grinding Machine.

ing pin being rightly situated to properly locate the work. Upon the fulcrum is also pivoted a gage, which is set so that its point will indicate when the work is ground to the right radius.

The work is ground, without traverse of the grinder, by swinging it slowly up past the face of the wheel, which is of such a width as to fully cover the work. Three cuts are necessary to bring it down to size, the last being a light or

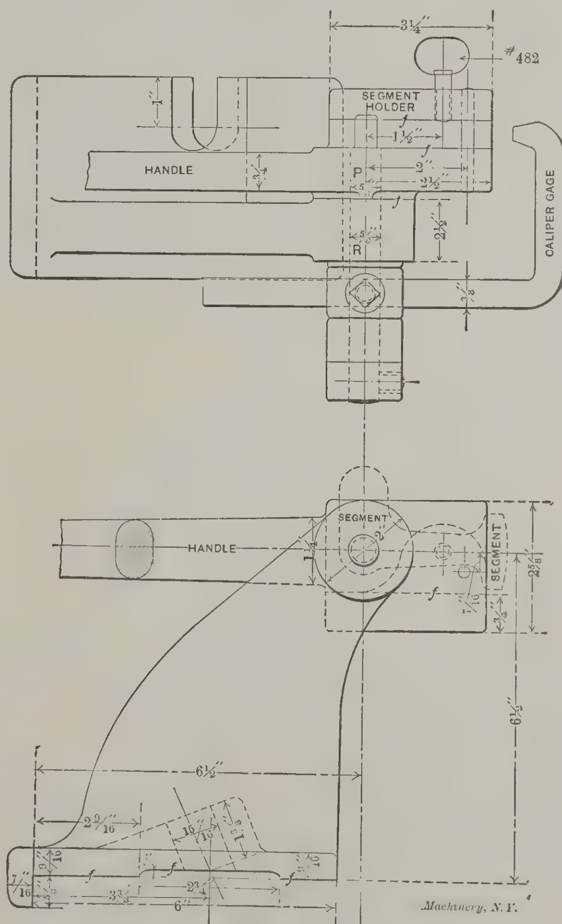


Fig. 3. Side Elevation and Plan of Fixture.

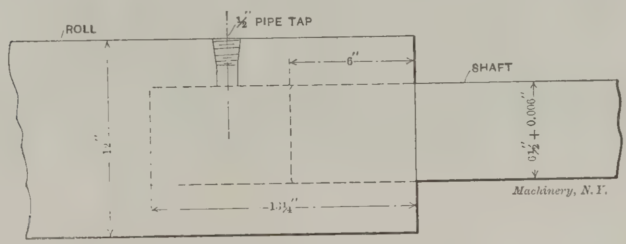
finishing cut. The material of these pieces was soft steel, and they were finished in this way at the rate of 40 per hour, the wheel showing average reduction for wear of about 0.001 inch for five pieces. Some of these were finished as fast as one in 38 seconds.

H. F. NOYES.

Waynesboro, Pa.

THE USEFULNESS OF HYDRAULIC PRESSURE.

The following occasion sets forth one of the many uses to which hydraulic pressure may be put. The top roll of our 10-foot plate bending rolls snapped off at the point where the driving shaft joins on during the process of rolling ¾-inch plate. The roll was then bored out to 6½ inches diameter for a distance of 13¼ inches. The corresponding end of the shaft was turned to a diameter of 6½ + 0.006 inch, as a shrinking fit had to be resorted to, there being no access to a suitable hydraulic press. The end of the roll was subjected to the proper degree of heat, and the shaft started to be put in place. Unfortunately, the rope loop supporting the shaft happened to exert a twisting strain on the shaft, causing it to twist the distance of half the width of the keyway. The few moments occupied in endeavoring to readjust allowed the roll to cool sufficiently to make it impossible to force in the shaft any further. The problem was then how to remove the



The Usefulness of Hydraulic Pressure.

shaft, as it had been inserted but six inches. Hydraulic pressure suggested itself, so the keyway was packed with lead very tightly; ½-inch pipe tap was tapped into the roll as shown in the cut; the hydraulic pump set to work, and with a pressure of 3,000 pounds per square inch the shaft was forced out. This instance suggests a novel use for such pressure, and one, which in our case, saved much valuable time and expense.

Springfield, O. CALVIN B. ROSS.

TO FIND THE RADIUS OF AN ARC WHEN THE LENGTH OF THE CHORD AND THE HEIGHT OF THE ARC ARE GIVEN.

I show herewith a method of obtaining the radius of a circle when the height of an arc and the length of its chord are given, thinking that there may be some of your readers who would like to put the formula in their note books. As shown in the sketch

A = apothegm of chord,
H = height of chord,
L = length of chord,
R = radius of arc.

$$\text{Then } R = \frac{\dfrac{\left(\dfrac{L}{2}\right)^2}{H} + H}{2}$$

This formula is derived as follows:

$$R^2 = \left(\frac{L}{2}\right)^2 + A^2 \qquad (1)$$

since R, A, and $\frac{L}{2}$ form three sides of a right angle triangle.

It is also plain that

$$R = A + H. \qquad (2)$$

Squaring this we have:

$$R^2 = A^2 + 2\,AH + H^2 \qquad (3)$$

Combining 1 and 3 we have:

$$\left(\frac{L}{2}\right)^2 + A^2 = A^2 + 2\,A\,H + H^2$$

Simplifying and transposing

$$2\,A\,H = \left(\frac{L}{2}\right)^2 - H^2$$

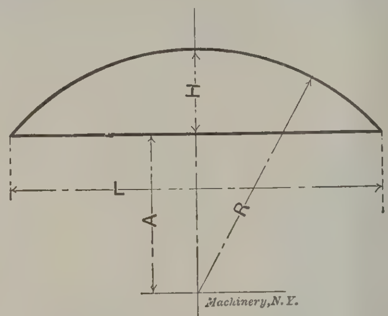
$$A = \frac{\left(\dfrac{L}{2}\right)^2 - H^2}{2\,H}$$

Substituting this value for A in equation 2 we have:

$$R = \frac{\left(\dfrac{L}{2}\right)^2 - H^2}{2\,H} + H$$

which simplified gives the formula proposed above.

When the height and radius are given this formula may be



To Find the Radius of an Arc.

rearranged to be used in finding the length of the chord, thus:

$$L = 2\sqrt{H\,(2R - H)}.$$

Find, for example, the radius when the height of the chord is ⅜ inch and the length of the chord is 1½ inch. Substituting these quantities in the formula given, and solving, we have:

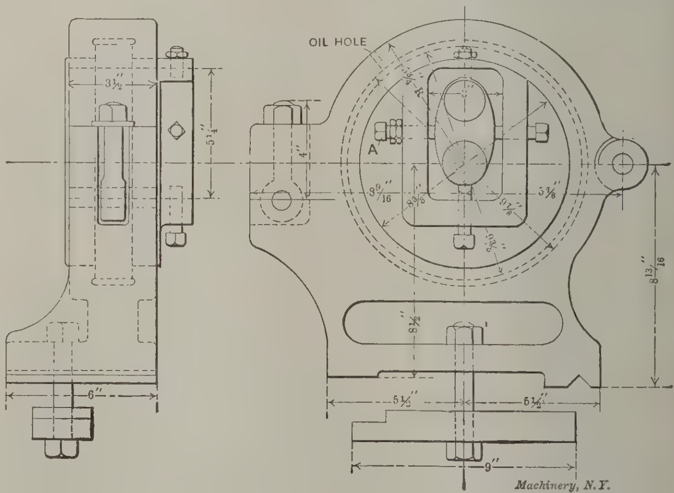
$$R = \frac{\dfrac{\left(\dfrac{L}{2}\right)^2}{H} + H}{2} = \frac{\dfrac{0.75^2}{0.375} + 0.375}{2} = \frac{\dfrac{0.5625}{0.375} + 0.375}{2} = \frac{1.5 + 0.375}{2} = 0.9375 = R$$

The radius is therefore 0.9375 inch, or 15/16 inch.

Torrington, Conn. E. C. FALK.

A CRANKPIN TURNING DEVICE.

The device shown in the accompanying cut was designed to turn the crankpins of small crankshafts so that they would be in line. The crankshaft for which this device was designed was of the drop-forged type, 2½ inches throw, with webs of the shape shown in the cut. The distance between the bearings was from 3 to 4 feet, so that in turning the



Device for Turning Crankpins.

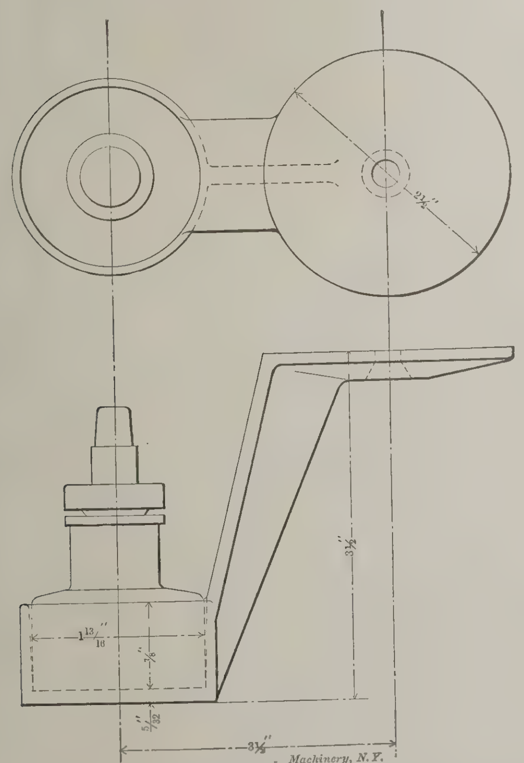
pins, the shaft would spring, consequently the pins would be out of line. After many complaints from the erecting floor, the drawing room "got busy," with this device as the result. I saw it working, and in my judgment it did "the trick." The idea is an old one, as I have seen it before in a more complicated form, but owing to its simplicity of construction and manipulation I offer it to the readers of MACHINERY, some of whom may have the same difficulties to overcome.

The device consists of two parts, a steady-rest, and a piece which I will call a chuck. The steady-rest is fitted to a lathe and bored out in place. The chuck is turned to a running fit in the rest. Before the shaft is put in the lathe, it is lined up on the planer and a light cut taken off the four sides of the web, just enough to make a flat surface for the setscrews to bear against. Another reason, in fact the most important one, will be explained farther on. The shaft is now placed in the lathe on centers which give it the desired throw. The pin is set central by means of the setscrews shown. When this has been done, the setscrew at the top is locked by means of the check-nut. The two check-nuts on the setscrew *A* are screwed against the side of the chuck. As it is necessary to move this screw when moving the crankshaft, two check-nuts are required; the first to indicate the position of the screw and the second to lock the first. The pin is now ready to be turned. After one pin has been turned, the setscrews on the bottom and sides are loosened and the device moved to the next pin. The top setscrew not having been moved, we have that point. Setscrew *A* is now screwed into its original position, made possible by means of the check-nuts. The other two setscrews force the web against these two fixed points and the job is ready for turning the other pin.

As all the flat bearing surfaces are in line and the setscrews occupy the same position after each setting, it will be seen that there is small possibility for the pins not coming in line. In taking the shaft out of the lathe, nothing has to be changed, as the hole in the chuck is large enough to allow the webs to pass through. H. M. C.

CONVENIENT INK BOTTLE HOLDER.

I noticed in the June issue of MACHINERY a neat arrangement for holding the ink bottle securely and "right side up." This matter has been a great source of trouble with most draftsmen and many schemes have been used. I always kept the bottle I was using in a drawer attached to the table, and found that a very effective method of overcoming the difficulty. We now have in our drawing room a bracket holder,



Ink Bottle Holder.

as shown in the cut. This holder is attached to the under side of the table by a single screw so that it may be swung around out of the way. This arrangement obviates the necessity of hauling everything around to find the missing bottle as it is always in the right place; it also eliminates the liability of blotting the work when filling the pen. The danger of spilling the ink is also reduced to a minimum. It seems that all the bad points of all other methods are overcome in the holder shown herewith.

Mr. Moody's arrangement is good, but the idea of using an ink bottle as a paper weight does not appeal to me as being satisfactory or advisable. My idea is that the drawing board is made to hold drawings, and drawings only, the fewer the better. JOHN EDGAR.

Hyde Park, Mass.

SINGLE-STROKE AND CONTINUOUS-RINGING BELL.

Referring to question 22 in "How and Why," September issue of MACHINERY, I give herewith a sketch of a single-stroke bell, Fig. 1; also a continuous-ringing bell, Fig. 2.

When the button in Fig. 1 is pressed, the plunger *P* will run up into the solenoid and strike the bell one stroke. In

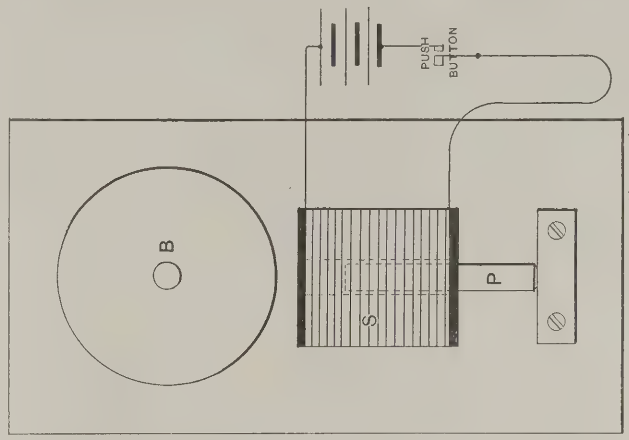


Fig. 1. Single-stroke Bell. Read Cut with Plunger Vertical.

the off position the plunger rests on a small wooden block. This device was installed at the Union Station, Minneapolis, by myself and works satisfactorily.

The continuous-ringing bell is constructed so that wire *a* from the right-hand solenoid crosses to the left-hand contact piece *b*, and the wire *c* from the left-hand solenoid crosses to the right-hand contact piece *d*. The switch is pivoted at *P* and when the plunger is in the position shown it is attracted toward the right-hand end. When it moves to the right-hand it touches the contact *d* and closes the circuit for the left solenoid and opens the circuit for the right solenoid. Then the left solenoid drives the plunger through to the left and

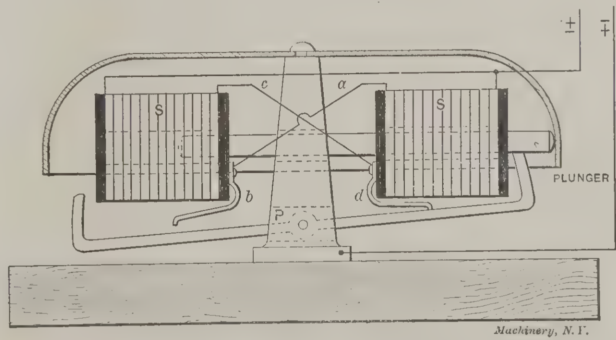


Fig. 2. Continuous-ringing Bell.

strikes the bell. The plunger is then an electromagnet because of the action of the coil and draws the left end of the switch toward it, the switch being made of iron. The switch then touches the left contact piece and closes the circuit for the right-hand coil and opens the circuit for the left-hand coil. The plunger then flies to the right and strikes the bell. The switch is hung so as to be slightly unbalanced, thereby securing contact to one of the coils and enabling the plunger to start. JOSEPH CHAMBERS.

Tacoma, Wash.

THE APPRENTICESHIP QUESTION.

The article on "The Apprenticeship Question" in the August issue was a very timely one, it seems to me, and came from a man who well understands the question, judging from

what I have read of his writings, but it seems to me there are some points that have been overlooked in his articles which would be helpful to all concerned. While my judgment may not be very accurate, it seems to me that many apprentices are not receiving the attention they are entitled to. Most boys, when they start to learn the machinist's trade, are ambitious to learn. Why is it, then, that after ten or twelve months' service in a shop this spirit is lacking? The boy is listless and has not the enthusiasm that he had at the start. What is the cause?

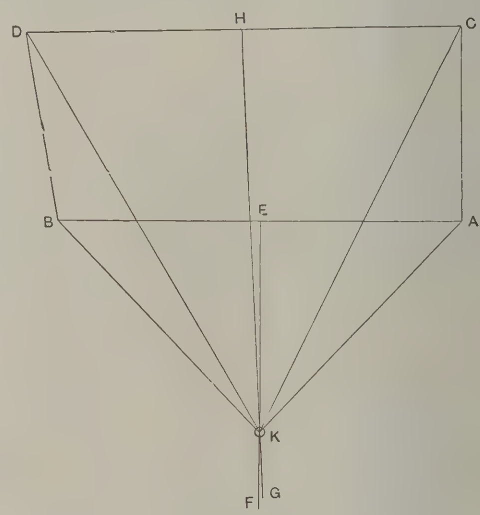
Just as long as apprentices are employed in shops there will be some who come in who are not adapted to the trade. The management is not always to blame for this, because there is no way of determining beforehand if the boy is mechanically inclined. But after ten or twelve months' service it should be possible to judge very accurately as to fitness for the work and during the probationary service the management should not be idle in their attention to the boy. If one wants results from a boy (or from a man, for that matter) he must be kept interested in his work. When put to a machine he must be shown explicitly how to operate it and the best way of performing the work. He must be given an opportunity to form an idea of what is required and it must be impressed upon his mind that it is important that he is doing all his work right. He must not be permitted to develop a slovenly manner of work. If his interest is kept up he will turn out far more work and it will be of a higher class comparatively. He must be given as wide a range of work as the shop permits, and the expectancy of better work will prove a strong incentive to good results.

A great many boys commence to complain of their pay after six or eight months' service unless there is a hard and fast schedule. As a preventative of this, it is advisable that time is taken to show the apprentice the cost of some of his work, and in many cases this is sufficient to cure the greatest "kicker," because it is well known that the ones who usually do the most "kicking" are the ones who perform the least work. If the apprentice had an idea of what he is worth and knew what the machine he is working with is worth per hour, including his services, he would be able to figure his output. This would give him the means to realize whether he is paid too low compared with his more skilled companions in the shop. The ability of estimating the cost of machine work is one that is very rarely ever taught an apprentice, but it is of the greatest value. It is gratifying to find that many of our large concerns are awakening to this fact and are establishing schools of instruction. Of course it takes time and trouble to show the apprentice the how and why, but it is better to spend the time thus than to spend it trying to catch him "playing possum." When I hear of an official complaining of his apprentices as being "no good," it lessens my respect for him as a shop manager. He is the man who is at least partly responsible for their failure as mechanics because of his lack of attention and interest in their development. It would be much better for him to have them brought up to be first-class mechanics and to give some of his time in accomplishing this than it is for him to hire any man that comes along to do his best work and afterward find that many a man whom he has hired is no better than those he has. The former he will pay high wages because he does not know them, but his own boys cannot get the same pay because, as he thinks, he knows them. This inconsistency is hard to understand. If the men in charge would spend more time and more interest in developing their own apprentices, teach them how to estimate, give them opportunities to gather information in mathematics and mechanical drawing, it would be found that it would be for the mutual benefit of all concerned. A few hours a week spent this way would cost the management very much less than an hour or two a day spent by every apprentice worrying over a blueprint, only to still get mixed up in the end and spoil the job. The foreman cannot be everywhere at once, although I have seen a few that were marvels in the latter particular, if you were not looking for them. A good idea would be for a manager to take a few trade papers and when through with them give them to the apprentices instead of throwing them in the waste basket. An apprentice should be accustomed to read things pertaining to his trade. If the boy will read trade papers at noon instead of dime novels, the man will be able to take a responsible place in time of need. It may be that some firms have the best way of doing things, as far as they can see, but it may be that upon considering the matter more closely things may look different. When the apprentice is doing well he should be encouraged as readily as he is blamed when he is doing wrong. If some one would try some of the suggestions put forth, it would be for the benefit of us all, if he would let us know of his experience. E. T. STRONG.

Urbana, Ill.

OLD EUCLID DISPROVED AT LAST.

If the editor would have permitted me I should have entitled this "Startling Revelation in the Science of Mathematics," and should have had the heading printed with 3-inch-high letters, because, in fact, my discovery is of so unique a character as to put me in a class with Newton and Pascal. For more than 3,000 years we have considered the statements of Euclid as unquestionable, but at last it has been possible by a simple method to disprove the truth of the very foundation of geometry! Draw a straight line, AB, as shown in the cut. From A draw a line AC at right angles to AB. From B draw a line BD at an angle larger than 90 degrees to AB. Make BD equal to AC. Draw CD. Divide AB in two equal



Old Euclid Disproved.

parts at E. Draw EF at right angles to AB. Divide CD in two equal parts at H and draw HG at right angles to CD. EF and HG intersect one another at K. Draw AK, BK, CK, and DK. We are now ready for the startling revelation. AEK and BEK are right-angle triangles. BE equals AE, EK is mutual for both triangles, consequently the triangles are equal and the angle EAK equals EBK, and the line AK is equal to BK. The triangles CKH and DKH are also equal, being right-angle triangles, with the side DH equal to CH and the side HK mutual to both. The side CK is then equal to DK. If we now consider the triangles ACK and BDK we know that AK equals BK, CK equals DK, and BD was originally made equal to AC. Consequently these triangles are equal, and the angle CAK equals the angle DBK. If from these angles we subtract the angles EAK and EBK respectively, which we have found to be alike, the remaining angle CAB is equal to DBA. The angle CAB is a right angle according to our construction. The angle DBA is larger than a right angle. We have proven them to be alike by means of the fundamental propositions of geometry. Hence Euclid must be wrong in the very first principles upon which he founds his geometrical propositions.

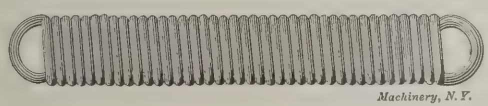
It may be that the editor will not consider my discovery epochal, and that it is the reason for his declining the 3-inch high letters for a heading, but even if his check should fail, I am convinced that my discovery is the very greatest in the field of science during the present year, and I expect to receive the Nobel prize for scientific research, which would

amply compensate me for my disappointment in regard to the 3-inch high letters for the heading, upon which my heart was particularly set.

R. S.

COMMENTS ON "TO INCREASE THE WORKING LENGTH OF COIL SPRINGS."

Referring to the article entitled "To Increase the Working Length of Coil Springs" in the August issue of MACHINERY, the writer wishes to call attention to some points not mentioned which will materially alter the case. In the two cuts shown in the article the working length of the open-wound spring appears greater than that of the close-wound spring. However, the distance a spring will safely extend is determined by the number of acting coils it contains, and not by the number of inches of working length. Each of the springs shown has about nine acting coils and therefore both the springs will be about equivalent in their action. Now, if the close-wound spring were made with one-half of each end coil bent up for hooks instead of using the tapered ends and forged hooks, several more acting coils would be added to each end of the spring without increasing the length over all, and consequently the close-wound spring could be made shorter for a given working length than could the open-wound spring with links. The cut shows a spring made in this manner. This is the style of hooks generally used on extension springs, being easier and cheaper to make and in 99 cases out of 100 gives fully as good service.



Increasing the Working Length of Springs.

There are, however, two important advantages in the open-wound spring with links, which are not referred to in the article mentioned; first, the impossibility of injuring such a spring by any reasonable overload. The spring simply compresses under overload until the coils touch and then acts as a solid connecting link; second, the fact that in the case of the coil part breaking the links act as a safety device maintaining the connection between the parts to which the spring is attached. For instance, when used as a trace spring to relieve the horse of the jars caused by the unevenness of the road, if the coil should break, the trace is still attached to the whiffletree and no runaway or accident follows.

F. E. W.

METHOD OF DIVIDING FRACTIONS BY TWO.

Under the heading, "Method of Dividing Fractions by Two," an article was published in the August issue, evidently with the intention of placing on exhibition the longest known method for cutting a fraction "through the middle." Mr. Lang attacks a fraction in about the same way as a farmer would cut off a piece of cold-rolled shafting, commencing with a file, then using a cold chisel for a while, after which he might take turns with the pipe cutter and milling machine, and if he did not happen to think of the emery grinder he would undoubtedly finish with the hacksaw, the tool which should have been used at the start. It may be that the other tools might do the job, but nobody is likely to care to wait for the result obtained in that way.

A man who cannot set his dividers to one-half the given fraction of the dimension for the diameter without looking up his table of decimal equivalents first should not expect pay for overtime. Although there are quite a few mechanics (?) who have passed through their apprenticeship and are still deficient in fractions, I do not believe that the given method will be of any assistance to any of them.

The quickest way is always the best. Try this: taking for example, $11/64 \div 2 = 11/64 \times \frac{1}{2} = 11/128$; cutting this short for convenience, we say $64 \times 2 = 128$, and using the same numerator we have 11/128. This principle is equally applicable to the division of fractions by any number. For instance, $7/9 \div 2 = 7/9 \times 2 = 7/18$, and by Mr. Lang's method we experience some difficulty in finding the decimal equivalents of 7/9 or 35/9, and even if such tables were available, the simple rule that you learned when you were nine years old would give the correct result quicker than you can find it in the table. Just add enough ciphers to give the proper number of places to the numerator and divide by the denominator; thus, $7/9 = 7.0000 \div 9 = 0.7777$, which is sufficiently accurate for a measurement with micrometers; by the same formula 55/64 becomes $55.000000 \div 64 = 0.859375$. I do not want to belittle the value of tables and note books; some of the data sheets are worth many times the price of the paper, but I am surprised to see a good mechanic waste his time in the way mentioned.

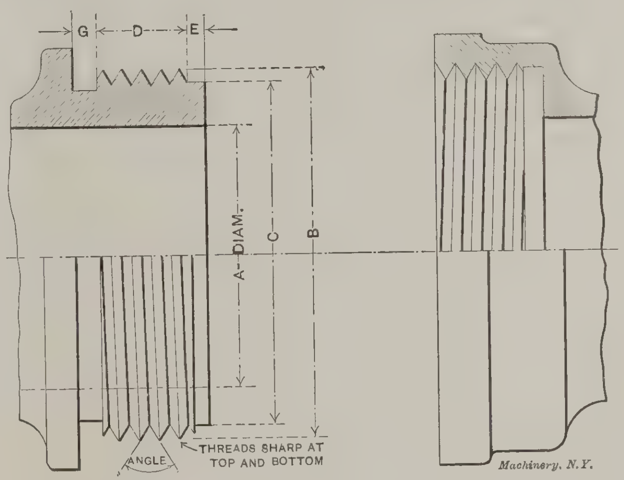
EUGENE PIERCE.

Ilion, N. Y.

[We are not at all sure that Mr. Pierce can carry out his lengthy divisions, particularly when halving 64ths any quicker than Mr. Lang carries out his simple multiplication and looks in his table, but the criticism is so unique in its certainty and in its comparisons that we felt under obligation to publish the matter and permit our readers to judge for themselves. To find the decimal equivalent at once, and divide it by two, seems the simplest way in regards to 64ths. In regards to 32ds, 16ths, etc., there seems to be no need of either multiplications, nor lengthy divisions, and Mr. Pierce is, of course, applying the correct principle for such cases, if he simply multiplies his denominator by two.—Editor.]

STANDARD HOSE COUPLING FOR NAVAL CONSTRUCTION.

There was published, in the July issue, Standard Hose Couplings, as agreed upon by the National Fire Protection Association. This standard differs somewhat from the one used in naval practice. The following table of dimensions



STANDARD HOSE FOR NAVAL CONSTRUCTION.

A	*B*	*C*	*D*	*E*	*G*	Angle.	No. of Threads per inch.
1/2	1 1/16	Bottom of Thread.	5/16	1/16	1/8	60° 0″	14
25/32	1 9/32	Bottom of Thread.	1/2	1/16	1/8	60° 0″	11 1/2
1	1 5/16	Bottom of Thread.	1/2	1/16	1/8	60° 0″	11 1/2
1 17/32	2 3/32	1 31/32	1/2	1/16	1/8	77° 20″	10
2	2 13/32	2 9/32	3/4	1/8	1/8	66° 18″	7
2 17/32	3 11/32	3 1/8	3/4	1/8	1/8	66° 18″	7
3	3 13/16	3 19/32	3/4	1/8	1/8	66° 18″	7
3 1/2	4 5/16	4 3/32	3/4	1/8	1/8	66° 18″	7
4	4 7/8	4 21/32	1	1/8	1/8	66° 18″	7
4 1/2	5 3/8	5 5/32	1	1/8	1/8	66° 18″	7
5	5 7/8	5 21/32	1 1/4	1/8	1/8	66° 18″	7
5 1/2	6 3/8	6 5/32	1 1/4	1/8	1/8	66° 18′	7
6	6 1/8	6 21/32	1 1/2	1/8	1/8	66° 18″	7
6 1/2	7 3/8	7 5/32	1 1/2	1/8	1/8	66° 18″	7
7	7 1/8	7 21/32	1 1/2	1/8	1/8	66° 18″	7
7 1/2	8 3/8	8 5/32	1 1/2	1/8	1/8	66° 18″	7

complies with the naval specifications for hose threads and may be of some value to the subscribers employed in marine works which are at times engaged in naval construction.

Brooklyn, N. Y.

A. H. NOURSE.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

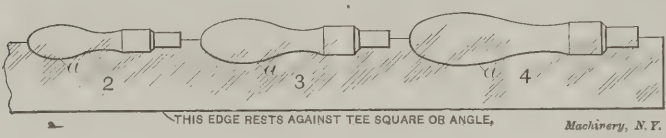
A HANDY SCREWDRIVER.

The machinist many times wants a small screwdriver, and the kind used by watchmakers do not have the "grip" needed. I made one like the cut from 3-32-inch steel wire, about 4 inches long, and it has seen many years' service and is

good yet. The part *A* is made of brass ½ inch in diameter, 3-16 inch thick, and knurled on the edge. The cup piece *B* is also of brass, dished as shown. F. H. J.

TEMPLATE FOR DRAWING MACHINE HANDLES.

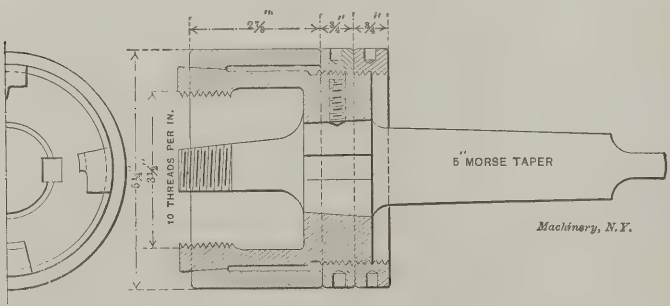
The drawing of machine handles may be facilitated very much by the aid of a celluloid template. Two templates are made, one containing profiles of the four smaller sizes, and the other containing the three larger sizes. If there is a forming tool for each size it is an easy matter to make the



templates and thereby have the drawings the same outline as the formers. They not only facilitate drawing, but also allow of a proper section for each requirement. The outline, *a*, of the lower half of the handles is scratched on the templates and is filled in with black wax. WINAMAC.

LARGE SPRING SCREW THREADING DIES.

Thinking that some of the readers of MACHINERY may be interested in a large spring screw die of which type I have designed several, the one in the accompanying cut being the largest, I hereby submit it for their approval. This die was made to use in a limited space, the collar and the check



nuts running within 1-16 inch of a projecting flange, it being impossible to use any other type of die. These dies work in a very satisfactory manner and are used on brass. They do not need a lengthy description, as the cut will explain their operation and construction satisfactorily.

Boston, Mass. LOUIS F. LANG.

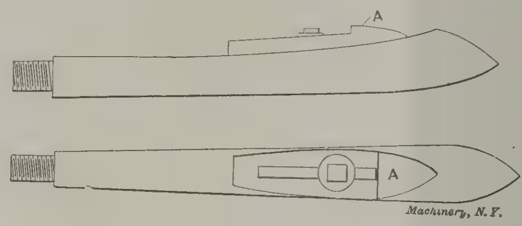
HOW TO PREVENT A UNIVERSAL CHUCK BECOMING CLOGGED WITH CHIPS.

Here is a way which I have used to prevent a universal chuck becoming clogged up with chips. Take apart the chuck and in the outer shell lay out three holes ⅝ inch diameter for a 6-inch chuck, midway between jaw race and pinion wrench holes, where it will weaken the shell the least, and a distance in from outer face of chuck so that the point of the drill will break through about 1-16 inch from the inner face. The holes should be drilled ½ inch further after the point breaks through, cutting a groove in the inner face with the lip of the drill. A ⅝-inch hole is about the right size for a 6-inch chuck; smaller or larger chucks would, of course, need smaller or larger holes in proportion. Use dry graphite instead of oil in the chuck. A chuck with holes drilled as above is specially good for turning composition metal at high speed, and will clear chips almost as fast as they get in.

South Boston, Mass. F. B. POOLE.

A PIPE PULLER.

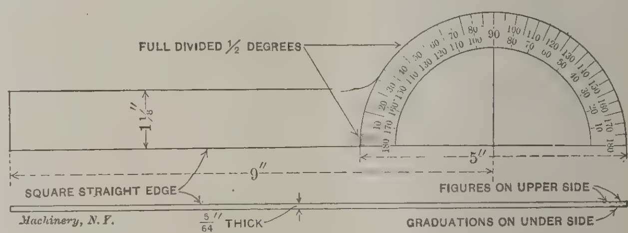
Did you ever have a pipe to pull out of the ground, that you could not get hold of? If so, the device shown in the cut will be of value in many cases. Of course it has to be made to suit the size of pipe inside. No explanation is necessary, as the cut shows the device very plainly. The tool is secured



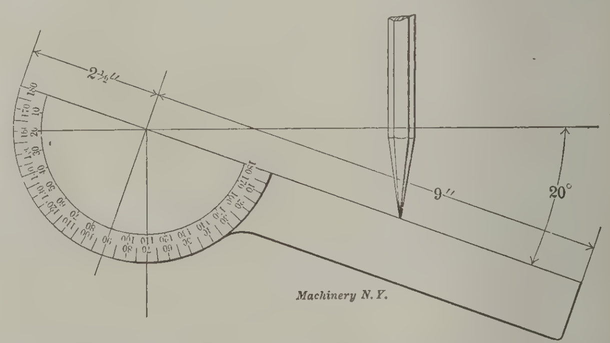
into a piece of pipe of proper length, and pushed down in the hole until the end enters the hole in the pipe to be pulled out. When the pull is made, the part *A* slips down, wedging in the pipe, and pulls the pipe out. F. H. J.

DRAFTSMAN'S IMPROVED PROTRACTOR.

I enclose a sketch of a protractor which was designed to meet the demands for one that would be better suited for dividing a circle than can be done with those now on the market. It is not intended to do the work that the B. & S. protractor can do, but principally to facilitate the plotting of angles for cams and cam charts. In laying out angles of this



kind or in general work with the ordinary protractor it is necessary first to point off the angle, then to remove the protractor and draw the line through the point. This protractor, having an extended arm, enables the operation to be done with the one setting. A number of draftsmen have shown their desire to obtain one, so an order has been placed with a



prominent manufacturer to make them, which is to be done at a reasonable price. They are made of transparent celluloid with the graduation on the under side. A few extra ones are now on hand as it was necessary to order more than were wanted. C. E. JOSSELYN.

Bridgeport, Conn.

* * *

Don't take a heavy stock cut off with a planer and then a finishing cut without letting up on the work and allowing all of the strain to come out.

* * *

Don't forget that after the stock cut is made on cast iron, every finger mark, or drop of water, or drop of oil, will show up when the finishing cut is made.

SHOP RECEIPTS AND FORMULAS.

A DEPARTMENT FOR USEFUL MIXTURES.

This page will be used for the publication of shop receipts which the contributors know from experience to be practicable. Nearly all readers of MACHINERY can add something, and it is desired that they use this page as a medium for exchanging useful formulas. It makes no difference if they are old and supposedly well-known, provided they have not already appeared in this department.

253. CEMENT FOR FASTENING TOOLS IN THEIR HANDLES.

Mix one part beeswax, one part fine brick dust and four parts black rosin. E. H. McClintock.
West Somerville, Mass.

254. TAPPING HOLES IN CAST IRON.

Kerosene oil used as a lubricant for tapping holes in cast iron is the best lubricant known to the writer.
Philadelphia, Pa. Wm. Davis.

255. ACID-PROOF CEMENT.

Mix a concentrated solution of soda with pulverized glass to form a paste. W. R. Bowers.
Birmingham, England.

256. FLUX FOR BRASS.

One ounce common soap, ½ ounce quicklime, ¼ ounce saltpeter. Mix into a ball and place in a crucible when lifted out of the furnace. This is sufficient for about 50 pounds of metal. W. R. Bowers.
Birmingham, England.

257. DUSTING FOR MOLDS FOR BRASS WORK.

To produce light castings of brass and gun-metal with a clean face and fine skin, first dust the mold with pea meal and on top of same add a slight dust of plumbago; for heavy castings dust only with plumbago. W. R. Bowers.
Birmingham, England.

258. A LUBRICANT FOR CUTTING THREADS.

After trying various kinds of lubricants in cutting threads on tool steel, machine steel, etc., I found that common lard (not lard oil) mixed with about one-third turpentine gave the best results. The mixture may be applied with a small brush.
Paterson, N. J. Stephen Courter.

259. ANTI-SLIP BELT MIXTURE.

To make a cheap anti-slip belt mixture and one that is very effective, use 95 per cent rosin and 5 per cent machine oil. Melt the two together slowly, taking care not to burn the rosin. When melted stir together thoroughly and apply warm, using a little at a time while the belt is running.
Pittsburg, Pa. Samuel Strober.

260. BLACK BRONZE FOR BRASS.

Dip the article, cleaned bright, in aquafortis (nitric acid); rinse the acid off with clean water, and place it in the following mixture until it turns black: Hydrochloric acid, 12 pounds; sulphate of iron, 1 pound, and pure white arsenic, 1 pound. It is then taken out, rinsed in clean water, dried in sawdust, polished with black lead and lacquered with green lacquer. Jos. M. Stabel.
Rochester, N. Y.

261. SELF-LUBRICATING BEARINGS.

In hard gun metal bushes, bored a good fit to shaft and split, drill four holes per square inch of surface, each ¼ inch diameter by ¼ inch deep. The holes are to be flat at the bottom and to be spaced zigzag, so that one row of holes is between the holes in the opposite side thus: . ˙ . ˙ . Fill the holes with a compound prepared as follows: Melt 1 pound solid paraffine and add 2 ounces of litharge, dissolved isinglass and sulphur; add further 2 pounds of fine plumbago and mix thoroughly. J. H. Holdsworth.
Toronto, Canada.

262. VARNISH FOR DRAWINGS.

Dissolve by gentle heat 8 ounces of sandarac in 32 ounces of alcohol. Another receipt is: Dissolve 2 pounds of mastic and 2 pounds of a lammar in 1 gallon turpentine without heat. The drawings must first be sized with a strong solution of isinglass and hot water. W. R. Bowers.
Birmingham, England.

263. TO WATERPROOF CLOTH TOOL BAGS OR CASES.

To waterproof tool bags or cases made of duck or other cloth, either of the following formulas may be used.

Use ½ pound of alum and 2 ounces of saltpeter dissolved in 1 quart of water. Immerse the article to be waterproofed in this mixture for 40 minutes, and boil hard; then rinse in cold hard water, hang up and let dry thoroughly before using.

Melt ½ pound of paraffine wax and mix in 1 quart of gasoline. Immerse the article in this and wring out and spread out to dry. In a short time it is ready to use.
E. W. Norton.

264. CEMENT FOR LEATHER BELTS.

To prepare a good cement for leather belts, soften equal parts of good hide-glue and American isinglass in warm water for about 10 hours. Mix the two ingredients together thoroughly and then pour on a quantity of pure tannin and boil until the mass is sticky. Just enough tannin should be added so that the mass will have a good consistency when boiling hot. To apply the cement, roughen the surfaces to be cemented and apply the cement while it is very hot. Press the parts together firmly and hold in that position until dry.
Olney, Ill. T. E. O'Donnell.

265. SOLDER PREPARATION FOR ALUMINUM.

The most successful solder preparation for soldering aluminum yet secured is made up in the following manner. Melt together 64 parts, by weight, of tin, 30 parts of zinc, 1 part of lead, and a small amount of rosin. All parts, of course, must be mixed together very thoroughly while in molten condition. When thoroughly mixed the alloy should be run out in bars of desired sizes. Clean the surfaces thoroughly and apply the solder. No chemical is required, the rosin used being sufficient to cause adhesion, although it is advisable to heat the parts to be soldered gently to assist in making a good adhesion. T. E. O'Donnell.
Olney, Ill.

266. TO BLUE STEEL WITHOUT HEATING.

When it is not desirable to blue steel by the heat process the following solution may be used with excellent results: Water, 1 quart; hyposulphite of soda, ½ ounce; acetate of lead, ½ ounce. Dissolve the acetate of lead and hyposulphite of soda in the water and then heat to the boiling point. The article to be blued should be thoroughly cleaned and dipped into the hot bath until the color changes to the required tint. It should then be removed, rinsed and dried. A more brilliant result is obtained by coppering steel articles with blue vitriol solution and then dipping. The same process may be used on both brass and copper with success. M. E. Canek.

267. SOLDERING WITHOUT HEAT.

Take 1 ounce of ammoniac and 1 ounce of common salt, an equal quantity of calcined tartar, and 3 ounces of antimony. Pound this well together and sift. Put this in a piece of linen, and enclose it well around with fullers' earth about an inch thick; let it dry, then put it in one crucible, covered by another crucible over a slow fire to get hot by slow degrees. Keep up the fire until the content of the crucible gets red hot and melts. Then let it cool gradually and when cold pound the mixture. When you wish to solder anything put the two pieces you want to join together on a table close to one another. Make a crust of fullers' earth, so that, passing under the joint and holding to each piece it shall be open at the top. Then throw some of the powder between and over the joint. Dissolve some borax in some hot wine, and with a feather dip in the solution and rub the powder at the place of the joint. It will immediately boil up. As soon as the boiling stops the consolidation is made. The calcined tartar is made by placing crude tartar in a covered crucible and raising it to a low red heat. Allow it to cool gradually.
Rochester, N. Y. Joseph M. Stabel.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

27. H. T. M.—What are the precise advantages of the bull-wheel used in planer construction. Do these advantages exist when the bull-wheel and the rack are cut with ordinary gear cutters?

A.—The use of the bull-wheel in planer work is largely because of constructive reasons. If the rack be meshed directly with the driving pinion, one of the reduction gears must necessarily extend above the level of the platen unless the rack be carried low. The introduction of the bull-wheel allows the reduction gearing to be all below the platen, and also gives the advantage, if it be one, of a large pitch circle to work with the rack; consequently the lifting action of the bull-wheel on the table is not as great (with the cycloidal tooth system) as it would be if a pinion were employed. With the involute tooth system, however, the angle of pressure remains unchanged for large or small gears so that this feature is really of not much importance. One successful American planer (Whitcomb-Blaisdell) is made without the bull-wheel.

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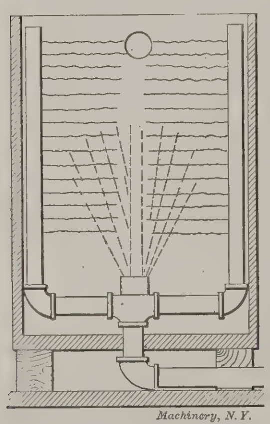
28. F. S.—1. How should a square wire spiral spring 5¼ inches long, 24 coils, 0.525 inch outside diameter, wound on a mandrel 0.35 inch diameter, wire 0.080 inch square, be hardened? This spring must be compressed into a square of 2 inches and must extend to its full length. The steel is 0.65 carbon. 2. How should tool steel rolls for rolling wire to a thickness of 0.023 inch thick by 0.237 inch wide be hardened? The rolls are 8 inches diameter by 4¾ inches face and have a hole through the center for a shaft 3½ inches diameter. They must be so hard that a file cannot touch the face and must be free from checks or cracks. The steel is 1.10 carbon.

Answered by E. R. Markham, Cambridge, Mass.

A.—1. In treating springs the desired final condition is elasticity and not hardness. Many times the hardener makes the mistake of getting springs too hard—and too brittle. Then in reducing brittleness the temper is drawn too low in order to let the spring stand up to its work; if the temper is not drawn low the spring breaks. When possible springs should be hardened in oil. If oil does not produce the desired result water must be applied instead, but it should be kept as warm as possible and still produce the desired hardness. Oil will work in most cases where the wire is no heavier than that stated in the inquiry, and even where it is several times the size, if the carbon content is sufficiently high. When oil fails to give the desired results it is generally because of lack of circulation or what is known as a "still" bath. Various expedients are employed to keep the oil in motion, but the best results follow when it is forcibly brought in contact with all parts of the steel alike, and this is accomplished in the case of a spring of the style under consideration by employing a bath of the form shown in the accompanying cut. There are six or more pipes extending up the side; these are perforated and the oil is forced through the opening toward the center. The pipes are so arranged that they may stand close to the sides of the receptacle or be swung toward the center for small work. The oil being projected against all parts of the spring alike insures uniform hardening and avoids the evils arising from the formation of gas next the work as occurs in a still bath. The stream of oil coming from the bottom also further agitates and forces the heated oil and gases to the top of the bath from which it is drawn off by a pump through cooling coils immersed in a tank of running water and then forced back through the hardening bath. Either lard or sperm oil works well, or in fact almost any fish oil answers nicely with such an arrangement. When drawing the temper best results follow if the springs are placed in a kettle of oil and the contents heated to the proper degree as denoted by an accurate thermometer. The exact temperature required cannot be stated as a great deal depends on the kind of steel used, the heat at which the spring was hardened and the use for which the spring is designed. However, if the spring be properly heated when hardened the temperature should not range far from 580 to 630 degrees F. For steel of the carbon content mentioned the first figure mentioned should be about the required temperature. 2. The hardening of rolls of the kind and purpose mentioned is not boy's play; it calls for experience and expert handling. A good grade of steel is required and one low in harmful impurities. The rolls must be carefully annealed before the machine work is completed. After boring the hole ⅛ or ¼ inch smaller than the finished size and turning off the outside surface or skin carefully, anneal the roll to remove all internal strain and then finish to size. When hardening the roll it must be carefully and uniformly heated; rapid heating is to be avoided as the outer surface at the ends will be heated much more rapidly than the balance of the piece. Rapid heating of such a piece means uneven heating and uneven cooling, consequently severe internal strains and bad results. If the carbon content is 1.25 or under, the roll should be packed in an iron hardening box with charred leather, and in charred hoofs, or charred hoofs and horns if it exceeds the percentage mentioned. The cover should be luted with fireclay and the box placed in a well-designed furnace where a uniform heat can be obtained. When uniformly heated it may be hardened in a bath of the description shown in the answer to question 1, using water or brine instead of oil. A jet of water from the faucet or hose should be allowed to play down upon the surface of the bath, as otherwise the end of the roll that is uppermost in the bath will not cool as rapidly as the remainder. Hence, uneven contraction will result. When dipping in the bath the rolls should be held by a rod passing through the shaft hole. It is possible to pack several rolls in one hardening box and to heat several boxes at a time in an ordinary furnace, thus making the cost of heating comparatively low. After hardening immediately remove the tendency to cracking from hardening strains by reheating over a fire, turning the roll while heating to insure uniform temperature throughout; heat until a drop of water will form steam when placed on the surface. Allow the roll to cool in a dry, warm place where no current of air can reach it. In conclusion would say that unless a shop is provided with suitable equipment for doing this work and great care is devoted to it the results will be unsatisfactory. Probably no one class of hardening has given more trouble in the past than this.



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An example of the beneficent effect of any medium that reduces shock and vibration is found in the rubber-tired carriage. Rubber tires for carriages have come into extended use during the past few years. They have the advantage of not only being noiseless, but the wear and tear on the body and wheels are greatly reduced. The shock to steel tires on an ordinary country road eventually loosens the spokes and wears the felloes, but with rubber tires all small obstructions are met yieldingly by the tires and the impact absorbed without transmitting the vibration to the wheels or body. It is claimed that while rubber tires are more expensive in the outset and for maintenance, the reduction in running repairs to other parts of carriages makes their use a positive economy.

* * *

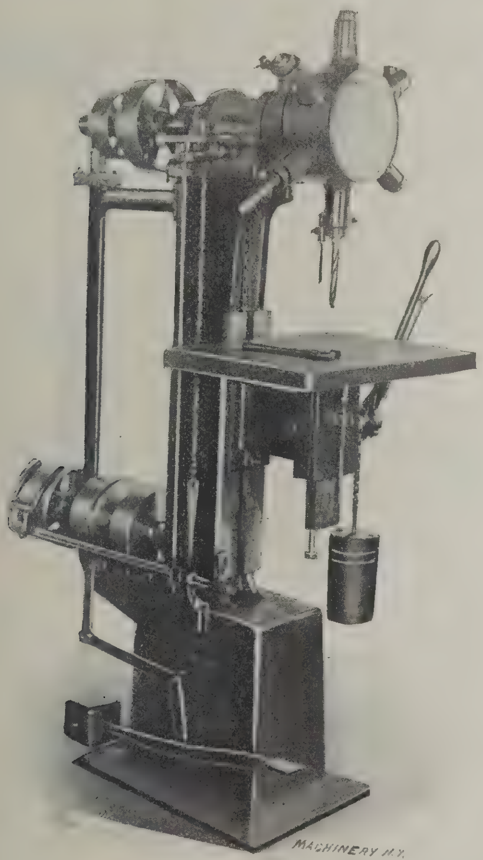
The enormous proportions of the Krupp Works at Essen, Magdeburg, Kiel, Annen and other places in Germany is more easily apprehended when it is considered that these works, and the coal mines operated in connection with them, had on the first of April, 1906, in their employ more than 62,500 persons, of whom more than 5,000 were officials and clerks. The company's principal plant in Essen consumes during one year as much water as does the entire city of Dresden, which has a population of over 400,000 inhabitants. It is also of interest to note for comparison with conditions in the United States that the average daily wage paid in 1905 to the workers in the cast steel plant was $1.22 per person.

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

IMPROVED TURRET DRILL.

A. E. Quint, of Hartford, Conn., has redesigned his well-known turret drill, introducing, among other improvements, an improved feed arrangement to the work table, involving the use of a ratchet hand lever with an adjustable counter-balance which may be accurately adapted to work of any weight. The head follows the usual construction in this machine, and may be made for 6, 8, 10 or 12 spindles, of which only the one in actual use rotates. The machine is provided with back gears and reversing friction clutch for tapping, the clutch being operated by the pressure of the foot on the pedal for the reverse movement. The release of the foot allows the forward clutch to engage itself. The machine allows a maximum distance of 20 inches between the table and the end of the spindle. The distance from the center of the spindle



Quint Improved Turret Drill.

to the face of the column is 8¼ inches, the size of the table is 14 x 20 inches, and the weight of the machine ready for shipment is 840 pounds.

HEAVY AUTOMATIC PINION CUTTING MACHINE.

The machine of which a front view is shown in Fig. 1 and a rear view in Fig. 2, is built by the Eberhardt Bros. Machine Company, 66-68 Union Street, Newark, N. J. As indicated by the title, it is particularly designed to cut steel pinions of coarse pitches at a fast rate of feed, as fast, in fact, as the cutters will stand. It is therefore adapted to manufacturing purposes where quantities of similar gears are required to be cut, as in the case of car motor pinions, and for jobbing as well, since the machine is capable of cutting the coarse pitches in iron, bronze and steel up to its capacity, which is 30 inches in diameter. Ordinarily when buying a machine for cutting pinions exclusively, in order to obtain a strong enough spindle drive to cut 2 or 3 diametral pitch in steel with heavy feed, the purchaser has been forced to pay for a machine capable of taking a 60-inch gear at the least, even though his work may be entirely confined to small diameters. The machine shown herewith is in fact practically a 60-inch machine furnished with a short column and simplified in many details that would need to be elaborated somewhat if the full capacity were used. One of the simplifications to which attention might be called, for instance, is the arrangement of the ele-

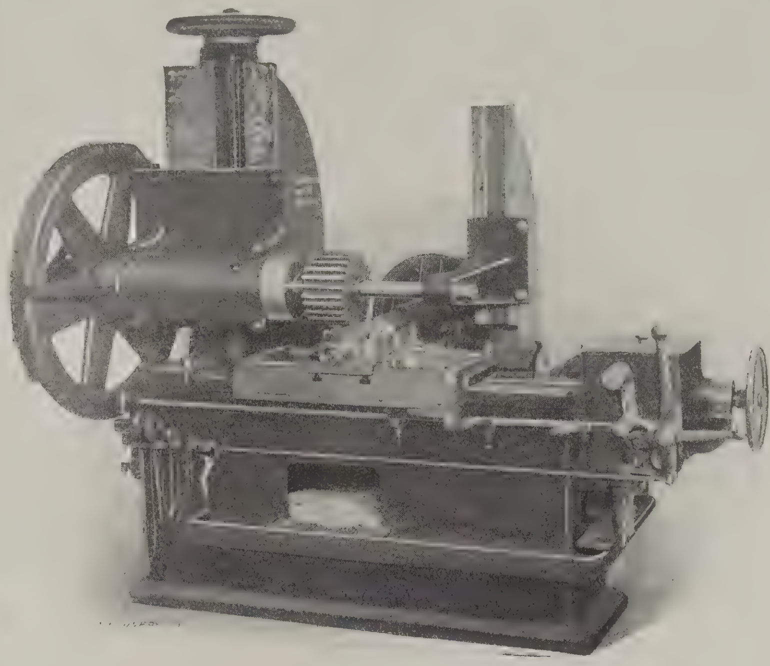


Fig. 1. Automatic Pinion Cutting Machine. Front View.

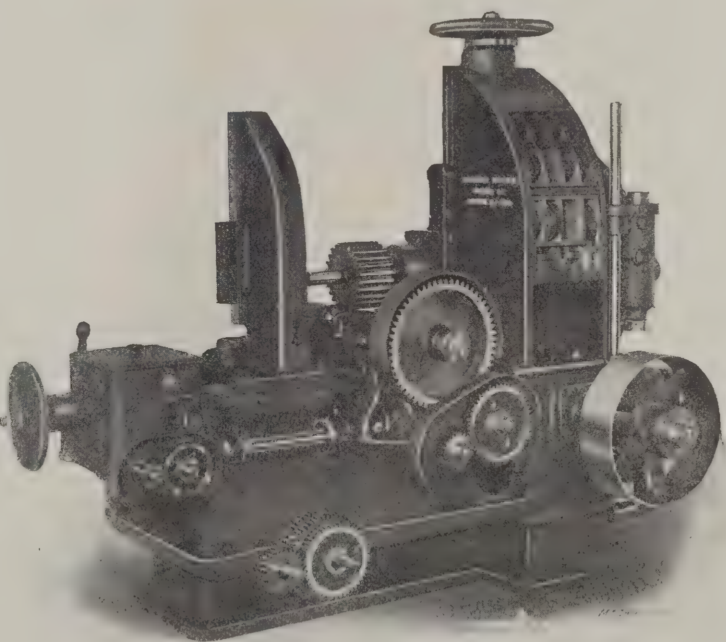


Fig. 2. Automatic Pinion Cutting Machine. Rear View.

vating screw and hand wheel for the work spindle saddle, this arrangement being possible on account of the shortness of the column.

Three of the prominent features of the design are the exceptionally long cutter slide with the spindle in the center, the placing of the thrust for the feed screw at the column end of the bed so that the slide is pulled instead of being pushed (a principle used throughout the design), and the unusually rugged drive for the cutter. In addition, the indexing and feed mechanisms are so constructed that the engagement of one precludes the simultaneous engagement of the other, thus

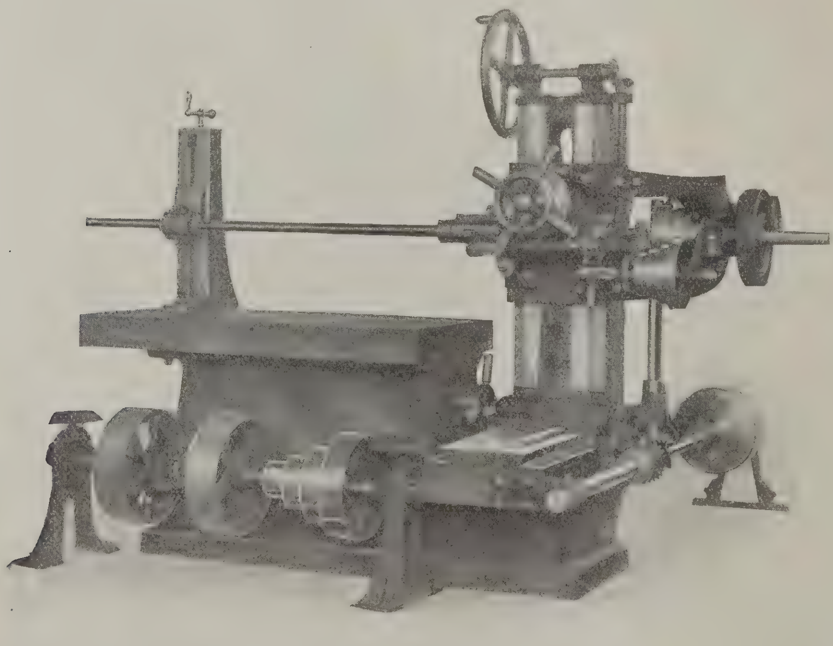
while the machine is indexing it is impossible for it to feed, and while the machine is feeding the indexing lever cannot be operated. These movements are automatically interlocked whether the machine is running or whether it is being adjusted by the workman.

The spindle driving arrangement is well shown in the rear view, Fig. 2. A large spur gear is mounted on the spindle, which is a tool steel forging of large diameter, and this gear in turn meshes with an elongated pinion below it, thus providing for lateral adjustment of the spindle and driving gear as a whole, and doing away with the necessity for a sliding key or keyway at this point. This lateral adjustment is so great, in fact, that it is possible to mount a roughing and a finishing cutter side by side on the arbor, as is done in the machine here illustrated. The changes in cutter speeds are obtained by change gears mounted as close to the spindle as possible. This permits the driving shafts to be kept at a constant high speed, subjecting them only to a comparatively light and unchanging torsional strain. The cutter speeds and feeds are, of course, independent, so that one may be changed without affecting the other. The spur gear for the spindle drive was adopted on account of its smooth running and high efficiency, as demonstrated by experiment.

The indexing wheel is of very large diameter, as can be seen, especially when compared with the range of work the machine is intended for. It is of the generated type and made very accurately. A graduated dial is provided reading to thousandths of an inch to facilitate the accurate setting of the depth to be cut. The work arbors are drawn in and forced out by means of the bolt at the rear of the work spindle. The frame of the machine is constructed to form an ample reservoir for the cutting lubricant. A special guard close up to the cutter compels the chips to fall directly into the base of the machine, from which they are removed either at the side or the front. Suitable strainers are provided for separating the chips from the lubricant.

NO. 2 BARNES HORIZONTAL DRILL.

The horizontal drill shown in the accompanying halftone is a recent product of the B. F. Barnes Co., Rockford, Ill. Its general arrangement is that of a horizontal boring machine. It has a stationary table 24 x 48 inches, to which the

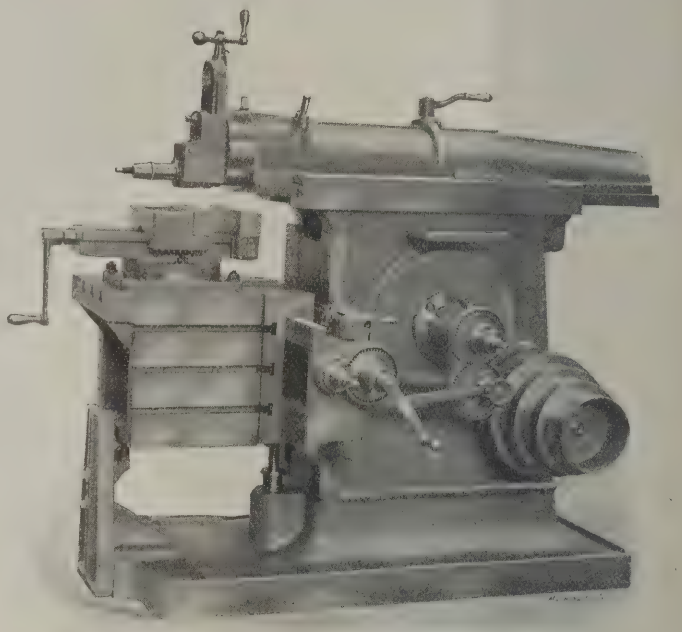


No. 2 Barnes Horizontal Drill.

work is clamped. The spindle is carried by a vertical adjustable saddle on a laterally adjustable column and has a longitudinal feed of 19 inches. The vertical adjustment of the spindle head is 18 inches. The feeding mechanism, located on the saddle, is power driven with an automatic stop, or may be operated by a hand wheel. All clamping levers and adjusting hand wheels are conveniently located and readily accessible to the operator from the front of the machine. A reversing friction countershaft is supplied with the machine. The spindle can be used at any point on a surface 36 inches long by 18 inches high. The spindle is 2 1-16 inches in diameter and is bored for a No. 5 taper. The cone pulley, for 3-inch belt, has the well-known internal back gear device used by this firm on its other drilling machines. The machine requires a floor space over all of 7 feet 6 inches by 8 feet 6 inches and weighs about 3,800 pounds net. The outboard boring bar support shown in the cut is furnished at extra cost.

TWENTY-ONE-INCH AVERBECK SHAPER.

The shaper shown in the accompanying halftone and built by the H. J. Averbeck Shaper Co., 52-56 E. Second Street, Covington, Ky., presents in its construction several unusual features. One of the most striking is the provision of an automatic stop for the table feed. A rod extends from end to end



Twenty-one-inch Averbeck Shaper.

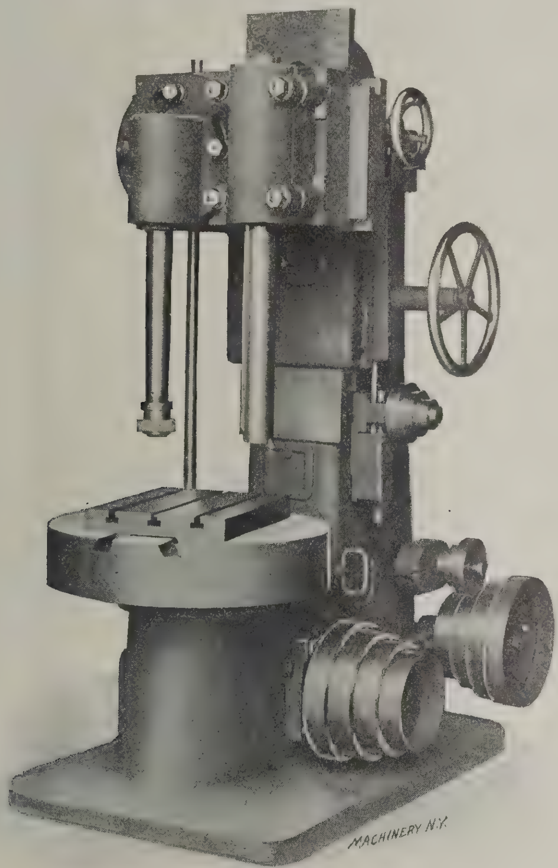
of the cross rail and on this are mounted adjustable dogs which come in contact with the table as it is fed in either direction, the resulting movement of the rod throwing the feed mechanism out of engagement. This enables the operator to adjust the machine for any length of cut he desires. Two stationary dogs are also provided which cut off the feed at the extreme travel of the table in either direction, so as to avoid all possibility of breakage of any part of the feed mechanism. The lever seen just above the gearing at the back of the rail is used to engage, disengage or reverse the feed. A "two to one" gear ratio is provided in the feed gearing which allows either a quick return or slow hand feed. Another novelty is in the design of the table support. This consists, as may be seen from the cut, of a vertical knee bolted to the base, carrying a roller in a vertically adjusted bracket on which the table is free to feed either to the right or to the left. This arrangement, while giving a firm outboard support, places the bearing surface in a position where it is not liable to be clogged with chips. The table is slotted on both top and sides, there being four of these slots on the top. The vise provided may be clamped on either side of the table or the table removed and the work clamped on the saddle.

The machine shown, which has a 21-inch stroke, may be shifted at will to work at a gear ratio of either 18 to 1, or 5 to 1. This, in connection with the 4-step cone, gives eight cutting speeds to the ram with a range of from 8 to 84 strokes per minute. The cross feed connecting rod is automatically

adjustable to any height of rail through the operation of the guide rod. The length of the stroke and position of the ram can be changed at any time from the working side of the machine. The extreme length of stroke is 21½ inches, the horizontal travel of the table is 26 inches, the vertical adjustment is 16 inches, while the feed of the tool block is 8 inches. The machine will take a 3⅛-inch shaft under the ram for key seating. The top surface of the table is 21¼ x 16 inches and the weight of the whole machine is about 3,200 pounds.

SAXON CYLINDER GRINDING MACHINE.

The Saxon Machine Co., 32 Main St., Room 10, Holyoke, Mass., have designed the machine illustrated for the special purpose of performing internal grinding operations on gas and gasoline engine cylinders, air compressor cylinders, and other similar surfaces which must be true, in good alignment, and accurately finished. It grinds to the center of a 24-inch circle and to a depth of 18 inches, regardless of the shape of the



Saxon Cylinder Grinding Machine.

work. The machine has, as will be seen, the general form of a vertical boring mill, including as it does an upright column provided with a slide for carrying the grinding spindle, with a rotating table at the base to which the work is attached. The main frame is a solid casting with a base for the faceplate and a column for the cross rail. The revolving faceplate has its bearings well protected from dust and is driven by the cone pulleys on the right side of the machine. It can be furnished with two sets of three T-slots each, crossing each other at right angles, or will be provided with a sliding table as shown. With this latter arrangement, duplex cylinders can be ground without altering the setting of the work. The cone pulleys provide eight speeds for the table. If desired, a geared speed box may be used in place of it.

The grinding spindle is of crucible steel, accurately turned and ground, and is carried by a sliding head attached to the cross rail. The bearings are of a special metal superior to phosphor bronze for this work. They are adjustable and protected from the dust. The feed of the head on the cross rail is accomplished by a screw with a dial graduated to thousandths of an inch. The traverse of the head is automatic, being controlled by a reversing rod actuated by dogs, which may be placed in any desired position, or it may be operated by hand with a lever provided for that purpose. Six rates of speed are provided for each speed of rotation of the work. These are obtained by the small cone pulleys shown or by a geared speed box, which will be furnished instead if so ordered. All the adjustments can be made from the operating

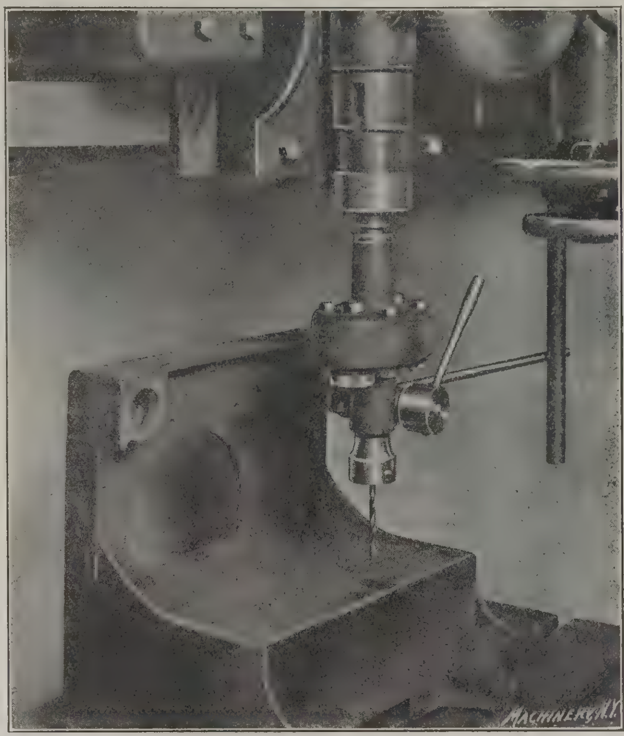


Fig. 1. Graham Drill Speeder in Operation.

side of the machine. The boring bar is an extra attachment which converts the machine into a boring mill for the roughing operations. The net weight of the machine is about 4,000 pounds.

THE GRAHAM DRILL SPEEDER.

Fig. 3 shows a halftone and Fig. 2 a line cut of the device shown in operation in Fig. 1. Its makers, The Graham Mfg. Co., Providence, R. I., call it a "drill speeder," and its purpose, as indicated by its name, is to allow the use of small drills at high speeds in machines which would ordinarily be too heavy and slow of movement for the work desired. A

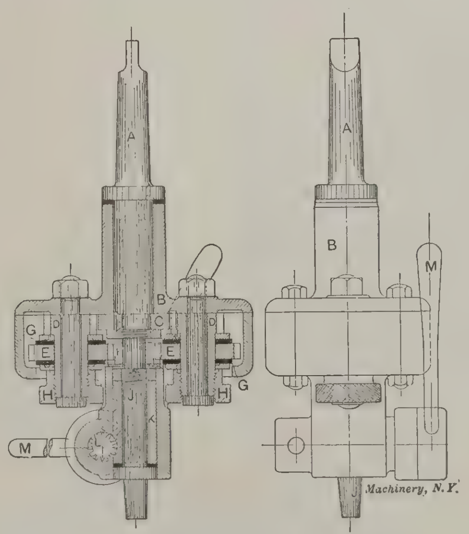


Fig. 2. Design of Graham Drill Speeder.

common condition met with by the machinists in the ordinary run of work is that of drilling oil holes 1-16 or ⅛-inch diameter in large castings which have considerable work to be done on them by the radial drill. Not only does the spindle of such a machine move too slowly for the work desired, but there would be difficulty in safely feeding so small a drill

with the large feed mechanism. This device gives, in such a case, the requisite speed and the required sensitiveness of feeding. The main body B is of cast iron. The upper part forms a bearing for the spindle A, which has a tapered shank and fits in the hole in the end of the machine spindle. The lower end of the casing forms a bearing for sleeve K, which carries the high-speed spindle. This sleeve is fed by the small pinion L with its attached handle M, in the same way that a sensitive drill press spindle is fed. A spring is provided which always returns handle M to its upper position. The high-speed spindle J is splined for a key in pinion F, but is free to move up and down, the upper end having a bearing within main spindle A as shown by the dotted lines. Gear C keyed to the lower end of spindle A through gears D and E, drives pinion F and through it spindle J at an increased rate of speed, in a way that will be readily understood from the cut. Gear E is not keyed to the hub on pinion D, but is prevented from turning on it by the pressure of friction washers G. This friction may be adjusted to any required degree by means of knurled nuts H, which project through the lower side of the gear casing.

Fig. 3 Graham Drill Speeder.

The device shown is the result of evolution, various designs having been tried out until a satisfactory arrangement was developed. The speeder is made in two sizes. No. 1 size has a speed ratio of 4 to 1 with a capacity for drills up to ¼ inch. The shank has a No. 3 Morse taper, with the speeder spindle fitted for a standard chuck. The length exclusive of the taper is 8½ inches and the weight 14 pounds. The No. 2 has a ratio of 3 to 1, with a capacity up to ½ inch. Its weight is about 18 pounds.

THE CATARACT BENCH MILLING MACHINE.

The bench milling machine shown in Fig. 1 is manufactured by Hardinge Bros., 1034 Lincoln Ave., Chicago, Ill., and is designed for general use by watch and clock manufacturers, instrument and toolmakers, and others having small accurate work to do. It is made, in part, of attachments provided for the new Cataract bench lathe, the headstock being the same as that used for the lathe; it has a half-inch hole through the spindle. The table of the machine can be lowered to 7 inches from the center of the main spindle; it is 12 inches long and is provided with three T-slots. All the screws have dials graduated to thousandths of an inch, making the machine valuable for use in laying out jigs and in die work.

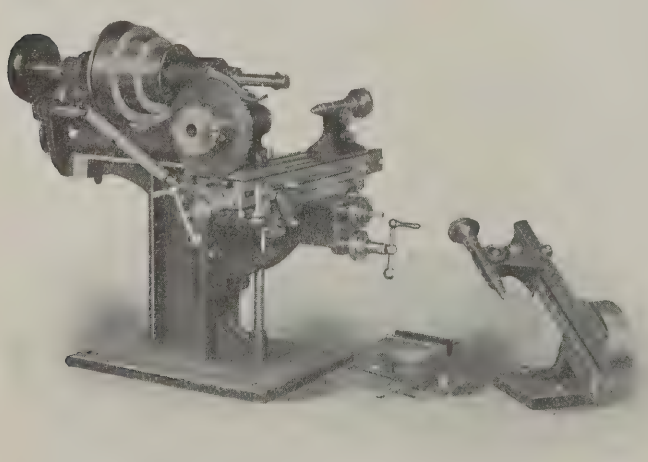


Fig. 1. Hardinge Bros. Bench Milling Machine.

The dividing head is 2½ inches from the center line to the table, and it carries a 4-inch index plate. The spindle is bored to receive a split chuck of the same design as that used in the lathe headstock and in the spindle on the same machine. This dividing head may be used in connection with the adapter shown at the right in the cut. This device allows the tailstock and index head to be set together at any angle up to 45 degrees, making it suitable for taper reamer and tap work. A small vise is provided for this machine, so that a great variety of operations may be easily performed.

The milling attachment to the regular Cataract bench lathe is built, as shown in Fig. 2, on the same general lines, being identical in every respect with the exception of the main frame. It will be noticed that to get the proper height for the frame above the bench the head stock is raised 3 inches above the top of the bed. Attention is also called to the countershaft arrangement here shown, which is provided with the lathe when desired. This countershaft has a cone at the right which is driven by a pair of gears and may be raised to the proper amount, so that the head can be taken from the bed and placed on the milling machine attachment without having to change the length of the belt. The same attachments as are used with the lathe are adapted for use with the milling machine.

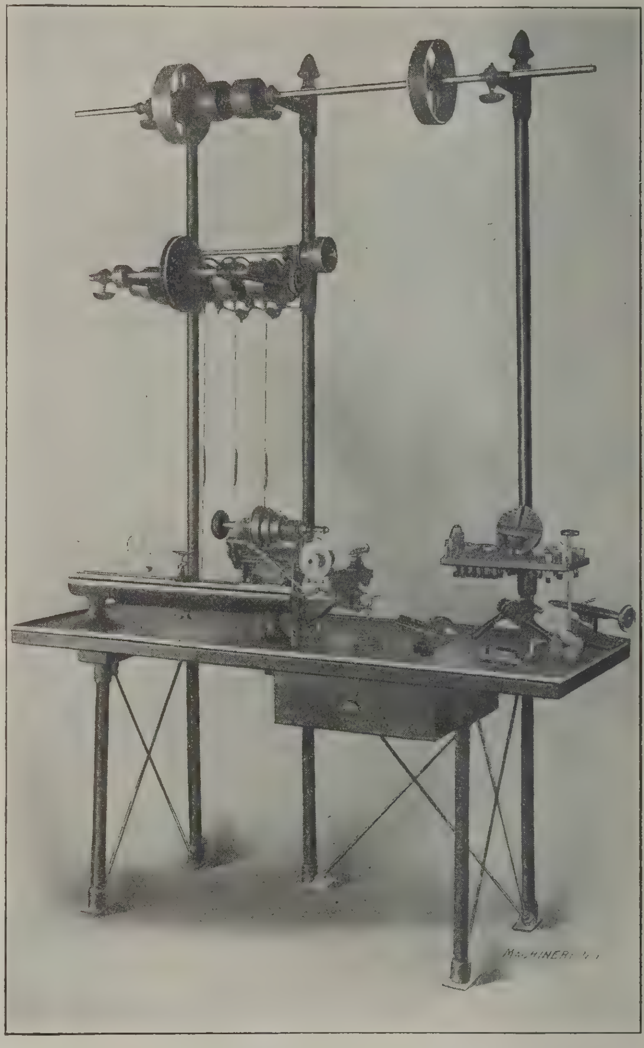


Fig. 2. Hardinge Bros. Bench Lathe Milling Attachment.

STANDARD 14-INCH CHAMPION ENGINE LATHE.

This lathe, of which a halftone view is shown in Fig. 1, is the product of the Champion Tool Works Co., 2420 Spring Grove Ave., Cincinnati, Ohio, and is designed to meet present-day conditions. The spindle, which has a 1 9-16 inch hole throughout its length, is of hammered crucible steel with round journals revolving in phosphor bronze boxes. Feeds can be reversed in either the apron or the head, and the apron mechanism is so arranged that the rod and screw feeds cannot be engaged at the same time. As shown in Fig. 2, lever B engages the slot in quill D, which is mounted on the splined feed rod. This quill carries the two bevel gears, E and E', either of which may thus be made to engage with large bevel

gear *F* of the feed gear train in the apron. Only when lever *B* is in the central position, and the bevel gears *E* and *E′* are out of mesh with gear *F*, can split nut *C C′* be closed upon the lead screw. The automatic stop is actuated by collars on the splined feed rod which may be clamped at any point on its length. This feed rod *W* has a limited end movement in either direction from the central position shown. Springs *X* and *X′*, bearing on collars *Y* and *Y′*, keep the rod in this central position normally. Gear *U* revolves loosely on *W* and is driven by gear *T* on the shaft above it. This gear *U* is provided with an internal chamber having clutch slots adapted to engage with a transverse driving pin in the feed rod. When the feed rod *W* is shifted to either side of the central position by the apron mechanism striking either of the adjustable collars, the driving pin is disengaged from the clutch slots in *U* and the motion of the rod is arrested. Either of gears *Q*, *R*, and *S* may be engaged with a mating gear on shaft *O*, thus giving three changes of feed.

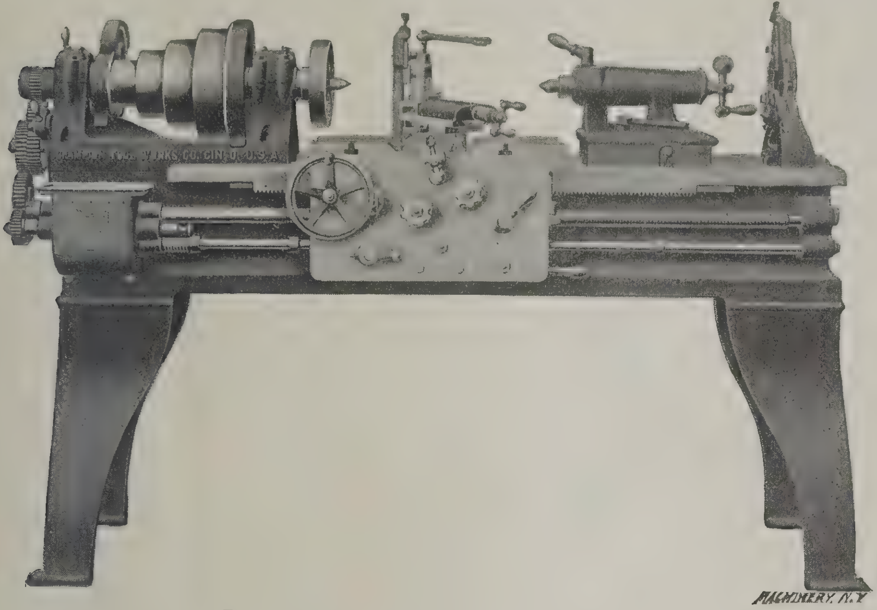


Fig. 1. Standard 14-inch Champion Engine Lathe.

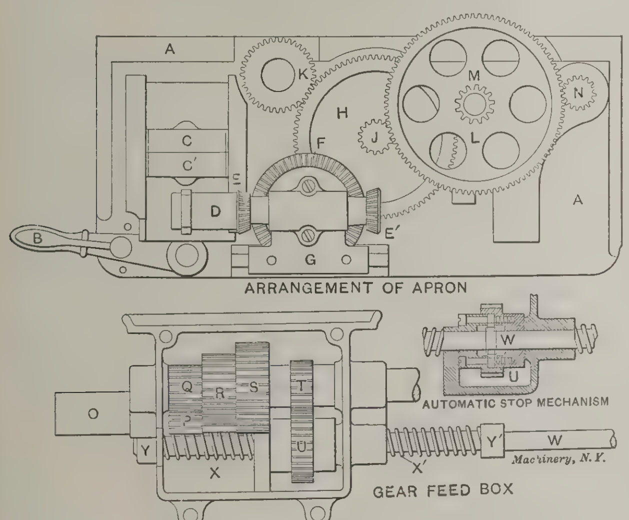


Fig. 2. Details of Champion Engine Lathe.

The machine, as shown in Fig. 1, has a 6-foot bed with a swing of 15 inches over the ways. The four-step cone is designed for a 2½-inch belt. The back gear ratio is 9 3-16 to 1. The net weight of the lathe with a 6-foot bed is 1,500 pounds.

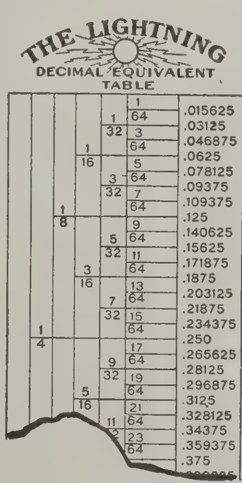
ADDITIONS TO THE LINE OF BICKFORD PLAIN RADIAL DRILLS.

In Machinery for January, 1906, was published a description of a line of plain radial drills developed by the Bickford Drill and Tool Co., Cincinnati, O. One of the prime features of the design was a speed change device in which the gearing was so proportioned that the revolutions per minute for any size drill is obtained with a great degree of exactness. The arrangement of the mechanism was also such that changes could be made instantly without shock, even while the machine was running at full speed. The 4-foot, 5-foot and 6-foot sizes of the Bickford plain drills have been redesigned along similar lines, the principle of the speed box being identical with that on the smaller machines. A somewhat different arrangement of the head is used on these larger sizes, however.

The feeding mechanism furnishes eight rates of feed ranging in geometrical progression from 0.007 to 0.064 inch per revolution of the spindle. Any one of these feeds is instantly available. The tapping mechanism is located in the head and permits the backing out of taps at any speed with which the machine is provided, regardless of the speed used in driving them in. It is operated by a friction clutch controlled by a lever within convenient reach of the operator. A depth gage is provided, which serves a double purpose. It is in the form of a graduated circular T-slot in a disk geared with the feed rack in such a way that its relative position with relation to the spindle is always constant. Besides enabling the operator to read all depths from zero without the usual delays necessary when scaling or calipering, it supplies a convenient means for setting the automatic trip. The graduations show exactly where each should be located to stop the feed at the desired points. This trip operates at as many different points as there are depths to be drilled at one setting of the work. In addition, it leaves the spindle free to be advanced or raised throughout its full length without disturbing the setting of the dogs. It also throws out the feed when the spindle has reached the limit of its movement.

HANDY TABLE OF DECIMAL EQUIVALENTS.

W. E. Gould, 142 Hazelwood Avenue, Detroit, Mich., has devised and copyrighted the "Lightning Table of Decimal Equivalents" of which a section is shown in the accompanying line cut. The original is about 4 inches long and has its edge graduated after the fashion of a 1-inch rule, although, of course, this makes the scale four times as great as the original. Each of the different fractions up to 1-64th, namely, the halves, quarters, eighths, sixteenths, thirty-seconds and sixty-fourths, has its own column in which the fractional quantity is placed. The decimal equivalents are in a vertical column at the extreme right. This arrangement is very convenient for quick reference, since it takes advantage of the user's already acquired quickness in reading a rule graduated in the ordinary manner, and has all fractions of the same denominator arranged in the same vertical column. It should prove useful to machinists, draftsmen, etc., and may be tacked up on the belt shifter, cemented to the T-square, or fastened in any other position for ready reference. Although printed on opaque celluloid, the marking is protected in such a way that it is permanent. The price is 15 cents.

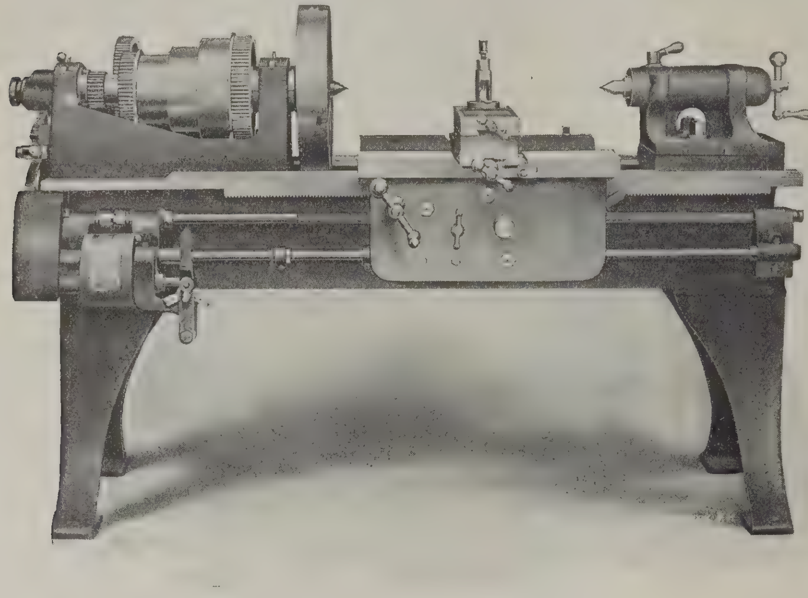


Handy Table of Decimal Equivalents.

THE WHITCOMB-BLAISDELL 16-INCH ENGINE LATHE.

This lathe is one of a new line which the Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass., have recently brought out to supersede the various other designs which they have hitherto built. The distinguishing features of this line are the rigidity of the design, the increase in effective belt power,

and greater facility of operation. The beds are of the box pattern. The increased power of the lathe is obtained by the use of double back gears with a three-step driving cone carrying a wide belt. Nine changes of speed are thus obtainable and the effective belt power at the different speeds is much more nearly equal than is the case where a four- or five-step cone is used. The smallest cone diameter is sufficiently great



Whitcomb-Blaisdell 16-inch Engine Lathe.

to give ample belt contact at the high speeds, so that on the other steps an excess of power is provided.

The feed mechanism has been strengthened throughout to agree with the increase in spindle power. Five changes of speed are instantly obtainable through the lever under the headstock. The friction which controls the feeds is self-adjusting and in such a position as to be easily and safely operated. An automatic stop is provided. A friction countershaft, large and small faceplates, and the necessary wrenches are furnished with each lathe. The swing over the bed for this machine is 18¼ inches, although it is rated on the 16-inch basis. There is a 1¼-inch hole through the spindle. The machine with a 6-foot bed weighs 2,100 pounds.

EVERETT McADAM CONTINUOUS ELECTRIC BLUE-PRINTING MACHINE.

A new blueprinting machine of the continuous type having a number of novel and interesting features is shown in the accompanying cuts, Fig. 2 being an elevation and Fig. 1 a line cut which shows the principle of the device. The result sought in the design of the machine is the ability to use blueprint paper directly from the roll without cutting into sheets, and to feed this paper to a continuously acting machine, to which the tracings are supplied continuously and as rapidly as the printing can be done. As shown, the roll of paper is contained in a box at the top of the machine, feeding out through an opening at the bottom. The box is light-tight and protects the paper when it is not in use. In the center of the machine is a large rotating cylinder of glass within which are mounted two mercury vapor lamps whose light, intensified by a reflector at the front, is used by making the prints. Four drums are placed around this central rotating cylinder with their axes parallel with it and a series of narrow belts run over these drums and around the cylinder, in such a way as to furnish a means for tightly holding the paper

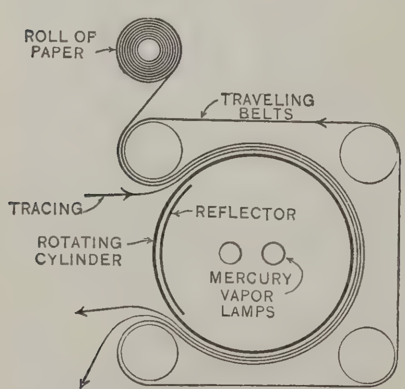


Fig. 1. Diagram of Electric Blueprinting Machine.

and the tracing beneath it to the revolving glass surface. As shown by the arrows in Fig. 1, the tracings are inserted between the paper and the belts at the upper part of the machine, and are delivered below, both feeding and delivery being at the front. Three-fourths of the surface of the glass cylinder is utilized for printing. The glass cylinder and the belts are kept in motion by a small electric motor having a variable speed controller which may be instantly changed to suit the depth of printing desired, the sensitiveness of the paper used, or the transparency of the tracing from which the print is made.

With this description of the machine in mind the advantages of the arrangement will be readily apparent. The blueprint paper itself, in continuous printing, is not touched by the hands; it feeds in of itself. There is no limit to the length of print which may be made. The machine being five feet long, a print may be made five feet wide and the length of a roll of blueprint paper. The mercury vapor lamp used requires no more attention than an incandescent lamp and has no carbon to renew. Inasmuch as the printing is done from the inside of the cylinder on the concave surface, all the rays strike the surface at practically right angles. All of the rays emitted by this form of lamp used are actinic, so that most effective transformation of electricity into chemical action is obtained. The machine is self-contained. To be put in operation it merely needs to be connected to the nearest electric light circuit, when both the motor and the lighting apparatus are ready for operation. Not only is this action continuous so far as the feeding of the paper is concerned, but its construction makes it unnecessary to use the "apron," found on some other machines, which has a limited

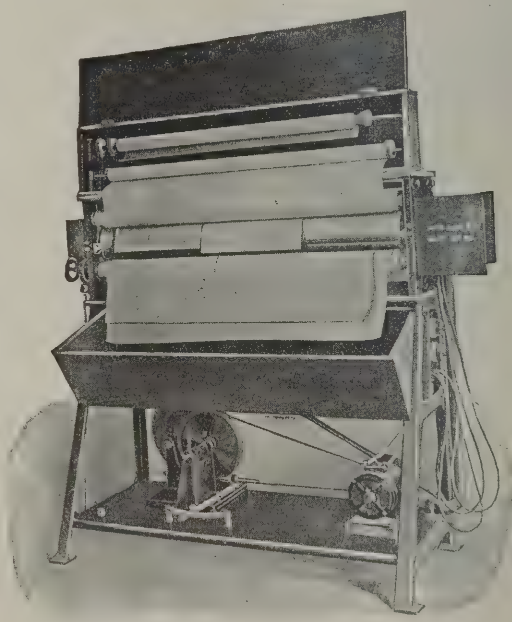


Fig 2. Everett-McAdam Electric Blueprinting Machine.

length and requires to be re-rolled after a certain period of operation, and to be renewed occasionally after a considerable period of service. It must not be thought that printing from the roll on sensitized paper is absolutely necessary; for any case where but one or two small prints are required, cut sheets may be fed to the machine in the same way as with other forms of automatic blueprinting machinery. A point which might be mentioned is that in printing from large tracings of which several reproductions are required, the leading edge may be fed back into the machine again as the trailing edge disappears, without wasting an inch of the sensitized paper, and still preserving the continuous printing feature.

The makers of this device, the Revolute Machine Co., 523 West 45th St., New York, state that, although the machine

has been on the market less than a year, there are already forty of them n daily use. The increased demand has made necessary the organization of this firm, which has equipped a shop exclusively for building them. The machine is very compact, requiring only a floor space of 2 feet by 5 feet.

* * *

DEDICATION OF THE NEW ENGINEERING BUILDING OF THE UNIVERSITY OF PENNSYLVANIA.

The University of Pennsylvania, on October 19, dedicated their new engineering building. The erection of this building was determined upon originally owing to the increasing needs of the engineering courses, and its early completion was made absolutely necessary by the burning of the former building devoted to the subject; it has been planned with the utmost care for the purposes to which it is devoted, by Prof. Spangler of the mechanical and electrical engineering courses, and Prof. Marburg, who fills the chair of civil engineering. The arrangement of this building and its laboratory equipment, in many respects unique, will be described with more or less detail in an early issue of MACHINERY.

The building, which had been decorated for the occasion, was opened for private view, throughout the day to the guests of the university. After a luncheon at 12:30 the dedicatory exercises were held in the large assembly room on the second floor. The invited guests, consisting of representatives of foreign countries and delegates from various schools and scientific societies, assembled there to witness the conferring of the degrees and listening to the addresses prepared for the occasion. The degree of Doctor of Science was conferred on Marie Michel Henri Vetillart, Alexander McKenzie, Charles Whiteside Rae, John Fritz, Mansfield Merriman, Samuel Matthews Vauclain, Frederick Winslow Taylor, Frederick Pike Stearns, Samuel Sheldon, Henry Wilson Spangler, Edgar Marburg, and Ramon Ivarrola. The addresses of the occasion were delivered by Frederick W. Taylor, who spoke on "A Comparison of University and Industrial Discipline and Methods," and by Alexander C. Humphreys, whose subject was "The Engineer as a Citizen."

* * *

FIFTH ANNUAL CONVENTION OF THE NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION.

The National Machine Tool Builders' Association met in New York October 9 and 10 for their annual convention, the headquarters being at the Hotel Breslin. Papers were read and discussed on various subjects of interest to the trade. One on apprenticeship was read by Mr. E. P. Bullard, Jr., of the Bullard Machine Tool Co., being a continuation of the work started at Atlantic City last spring. The committee on apprenticeship was continued. Mr. J. N. Gunn, of Gunn, Richards & Co., New York, was introduced by Mr. Fred. A. Geier, of the Cincinnati Milling Machine Co., to speak on costs and cost-keeping. Mr. Geier added some remarks urging the desirability of a more uniform method of keeping costs in machine tool shops, and his remarks were supplemented by Mr. Rivett, of the Rivett Lathe Mfg. Co. The general report was that the machine tool business is thriving all over the country. The following officers were elected for the coming year: President, E. M. Woodward, Woodward & Powell Planer Co., Worcester, Mass.; secretary, P. E. Montanus, Springfield Machine Tool Co., Springfield, Ohio; first vice-president, Wm. Lodge, Lodge & Shipley Machine Tool Co., Cincinnati, Ohio; second vice-president, F. E. Reed, F. E. Reed Co., Worcester, Mass.; treasurer, W. P. Davis, W. P. Davis Machine Co., Rochester, N. Y. The usual entertainments of the delegates were tendered by the *American Machinist* and MACHINERY. The location or time for the next convention was not definitely decided upon.

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MACHINERY'S ANNUAL OUTING.

Four hundred and thirty-odd machine tool builders, mechanical engineers and others identified with machine construction and distribution in some capacity or other, accepted MACHINERY's invitation for its annual outing on October 10, and most of them were on the steamer *Sagamore* when she left Twenty-first Street for West Point on the forenoon of that day, the afternoon and early evening being spent on the trip, covering a distance of one hundred and eight miles. About an hour and a half was spent at the nation's Military Academy, looking over the grounds and watching the training of Uncle Sam's future lieutenants, captains, majors and generals. All who could be gathered together were grouped on a steep and slippery hill behind a battery and shot at by a man with a 12 x 22 camera. Some escaped.

These outings were instituted by MACHINERY for the purpose of bringing together people who are particularly interested in machine tools and kindred lines, so as to promote good fellowship in the trade and enable those who attend to greet their old friends and make new ones. In this and other ways the outing appears to have been a success, and MACHINERY was proud of the fine body of representative men whom this occasion brought together.

* * *

PERSONAL.

Carl H. Au, instructor in mechanical engineering, Worcester Polytechnic Institute, has resigned to accept a position with the American Steel & Wire Co., of Worcester, Mass.

Louis H. Frick, Cheyenne, Wyo., has resigned as assistant superintendent of the American District Steam Co., to accept the position of manager of the Cheyenne Light, Fuel & Power Co.

Louis Block, for twenty-four years with the De La Vergne Machine Co., New York, and for more than twenty years at the head of its engineering department, has opened an office at No. 45 East 42d Street, New York, to serve clients in the capacity of consulting engineer.

* * *

FRESH FROM THE PRESS.

HENLEY'S ENCYCLOPEDIA OF PRACTICAL ENGINEERING AND ALLIED TRADES. Edited by Joseph G. Horner. Volume 1 (A-Boi) and 2 (Boi-Fil), each containing 240 pages 7½ x 9½ inches, profusely illustrated. Published by Norman W. Henley & Son, New York. Price per volume, \$6.00; \$25.00 for the set of five.

This work, which is to be completed in five volumes, necessarily is broad in scope, and simple and practical in its treatment of technical subjects, being intended for everyday use by craftsmen and others having to do with practical engineering. The subjects are arranged alphabetically in the usual encyclopedia style. The complete work will contain upwards of 10,000 topics, 2,500 pages, and nearly 3,000 engravings. Mr. Horner, the editor, is a well-known English writer and compiler of technical literature, and it may be said that he has devoted his energies conscientiously to this work in review. The work, although "shoppy," is distinctly English in its tone, but this is not particularly disadvantageous, for English engineering practice is well worthy of the study of American mechanics. Many of the illustrations are halftones printed on plate paper, a feature which adds distinctly to the value and worth of the work. The subjects treated mathematically, such as thermodynamics, beams, steam, etc., were written by men who combine experience of a practical character with scientific training. The method of treatment, which has been adopted, avoids the evils of very long articles on any one subject; instead of treating the subject of engines or lathes or machine tools, for example, in one comprehensive article, a general survey only is given under those heads, and then each type of engine or lathe or machine tool is treated separately under its proper heading, such as blast engine, axle lathe, planing machine, etc. This makes the finding of a specific subject simpler than when treated exhaustively under one head.

RAILWAY ORGANIZATION AND WORKING. Edited by Ernest R. Dewsnup. 498 pages, 5 x 8 inches. Published by the University of Chicago. Price \$2.00.

This book is a compilation of special lectures delivered before the classes of the University of Chicago on the subject of railway transportation during the period extending from November, 1904, to May, 1906. These were delivered by officials of various railway systems and have been brought together and edited by Mr. Dewsnup in the form of an attractive but not wholly balanced volume treating authoritatively, in a sense, upon various features of railway organization and working. The subjects by chapters are as follows: The Work of the Law Department of a Railroad Company; The Passenger Department; Railroad Advertising; Suburban Passenger Service; The Industrial Commissioner; The Problem of Handling Less-Than-Carload Freight Expeditiously and Economically at Terminal Stations; Office Work in Terminal Yards; Car Distribution and the Supervision of Fast Freight; The Problem of Car Service; Freight Claims; Some Notes on Freight Rates; Organization of the Operating Department of Railroads; The Purchasing Agent: Ballast; Railway Terminal Facilities; Railroad Signaling; Classification of Types of Locomotives; The Compound Locomotive; Car Construction; Duties of a Controller or Chief Accounting Officer; The Auditor of Expenditures; The Work of the Freight Auditor; Vitalized Statistics; Railway Development in Canada; Railway Education; Appendix.

MANUAL OF WIRELESS TELEGRAPHY, by A. Frederick Collins. 232 pages, 2¾ x 7¼ inches, 90 cuts. Published by John Wiley & Sons, New York. Price \$1.50, cloth; \$2.00, morocco.

The book has been written for the purpose of giving a clear idea of the principles and apparatus used in wireless telegraphy to general readers, but more especially to those who would become wireless telegraph operators or experimenters. The description of an experimental wireless telegraph which can be constructed at small expense will interest amateurs and experimenters. The elementary theory is discussed at some length, following which the book describes the various wireless telegraph systems, including the Marconi, DeForest, Telefunken, Clark, and Fessenden. A chapter is devoted to adjusting and operating the instruments which, of course, is a very important part of an operator's knowledge. Examples of the wireless telegraph alphabet, which differs somewhat from the regular Morse alphabet, are given. It includes a list of stations equipped with Marconi apparatus and a sample chart for April, 1906, showing the intersections of

points of earliest communication on the Atlantic with the various steamships equipped with a Marconi apparatus. The book concludes with a glossary of wireless telegraph words, terms and phrases. It is a readable and, we believe, reliable work on the subject and just what a practical man interested in the subject would like to get hold of.

NEW TRADE LITERATURE.

Chas. A. Strelinger & Co., Detroit, Mich. "Book of Tools," being a 550-page catalogue of tools, machinery and supplies.

Saxon Machine Co., 32 Main Street, Room 10, Holyoke, Mass. Pamphlet describing and illustrating Nos. 2 and 3 surface grinders. Dimensions for same are included.

The Tabor Mfg. Co., Eighteenth and Hamilton Streets, Philadelphia, Pa. Catalogue illustrating and describing the Tabor hinged machine, its operation, sizes and special features.

Warner Instrument Co., 56-59 Roosevelt Avenue, Beloit, Wis. *Auto-Speed*, a monthly magazine devoted to the interests of the autometer and containing items of interest to automobilists.

Newhall Chain Forge and Iron Co., 9 Murray Street, New York City. Catalogue No. 101, descriptive of hand forged crane, block and hoisting chain and method of manufacture.

Latshaw Pressed Steel and Pulley Co., Pittsburg, Pa., have issued a new folder giving price list of the Latshaw steel split pulley and illustrating the six-, twelve-, eight- and sixteen-arm pulley.

Fay & Scott, Dexter, Me. New catalogue No. 12, treating standard engine lathes. Special features of these lathes are outlined in the first part and specifications and illustrations of the different sizes follow.

Ingersoll-Rand Co., 11 Broadway, New York City. Catalogue No. 45 B—Rock Drills, describes these tools in full and illustrates them working in various excavations, as the Hudson River tunnel, construction of the Eastern Chinese Railway, etc.

Coates Clipper Mfg. Co., Worcester, Mass. Bulletin No. 20, describing worm feed drill press, flexible shaft buffing outfit, flexible speed multiplying grinder, and other apparatus for flexible transmission.

The Milwaukee School of Trades, Inc., 156 Clinton Street, Milwaukee, Wis., have issued a prospectus for the year 1906-1907. The book sets forth the purpose of the school, its organization, maintenance, etc., and outlines its system of instruction and the courses offered.

Crocker-Wheeler Co., Ampere, N. J. Bulletin No. 69 describing a specially arranged generator for direct connection to steam or gas engines. These generators are built in sizes to give outputs of 1½ K.W. to 19 K.W. and meet the demand for small direct connected units for isolated plants and residences.

The Cincinnati Planer Co., Cincinnati, Ohio, have issued a new catalogue descriptive of their line of planers. These planers have been redesigned with special reference to high speeds. Attention is also called to the variable speed planers, several types of which are illustrated.

The Joseph Dixon Crucible Co., Jersey City, N. J., publish an interesting pamphlet on the subject of steam traps. It is an illustrated description of the several varieties, with valuable suggestions by W. H. Wakeman, expert steam engineer and author of well known books on steam engineering.

The Gleason Works, Rochester, N. Y., have given us something out of the ordinary in their new catalogue on gear planers. This is most attractively gotten up in its artistic arrangement and in the high grade of cuts used. The descriptive material is confined to the front of the book, halftones of the various planers following, and line cuts showing mandrels used on the planers completing the material.

E. R. Markham, 66 Dana Street, Cambridge, Mass. Folder announcing that Mr. Markham will give advice in machine shop methods, designing special machinery and tools, hardening, tempering and annealing steel. Those who wish to consult him should advise him of the questions to be answered and he will notify them of the fee required.

Bulletin No. 139, which has just been issued by the B. F. Sturtevant Co., of Boston, Mass., in its engineering series, presents a full line of generating sets driven by direct-connected vertical enclosed engines with forced lubrication. The published list contains fourteen sizes ranging from 3 to 50 K. W. in output; the former driven by a 3½ x 3 engine and the latter by a 12 x 10. All of the engines were especially designed for generator driving.

Sprague Electric Co., 527 W. 34th Street, New York City. Pamphlet No. 314 on electric motors for driving ventilating fans and blowers, giving general descriptions of a few types of motors and including a list of installations of ventilating apparatus operated with the Sprague Electric Co.'s motors. Bulletin No. 219 takes up round type direct current motors. This includes description of the motors, specifications for different types and illustrations of the application of these motors to various machines.

Montgomery & Co., 105-107 Fulton Street, New York City, have issued a novel form of catalogue, No. 24, listing Grobet Swiss files, machinists' hand taps, music wire, emery wheels, twist drills, etc. This matter is arranged in tabulated form on two folders pasted within a strong manila cover. The pages of the folder, starting with the one pasted to the cover, are of decreasing width so that the titles of the pages form an index, showing at a glance where the particular table or list is to be found. The convenience of the arrangement can only be appreciated by an examination of one of the folders. They are sent to any address upon application.

The S. Obermayer Co., with factories in Cincinnati, Chicago and Pittsburg, have recently placed on the market a new factory riddle which is stronger and has greater wearing qualities than any riddle heretofore manufactured. The main feature of the new riddle is that the rim and liners lap; a strip of galvanized iron is bent squarely over them which prevents the joints catching and breaking when brought into contact with other objects. The name adopted for the new riddle is the "Rockwell." Descriptive circulars will be sent upon request.

The Yale & Towne Mfg. Co., 9 Murray Street, New York City, have conceived an original idea of assisting their dealers to market goods sold to them. They issue a booklet entitled "Suggestions for Selling Yale Padlocks," in which they tell their dealers the means that they have prepared to secure the buyers' attention. These include some printed matter; a book about padlocks, containing many suggestions for the uses of padlocks; a catalogue of the complete line of Yale & Towne padlocks; for those who do not care to read technical descriptions a story entitled "The Little Black Box" illustrating the merits of the Yale padlocks. Package labels, envelopes, etc., are also supplied. All of the above matter is given to the dealer free of charge and his name and address printed upon it.

The American Locomotive Co., 111 Broadway, New York City, have just published a pamphlet, "Consolidation Type Freight Locomotive," which describes and illustrates a large number of the consolidation locomotives built by the company for various railways. The description includes only consolidation locomotives weighing less than 175,000 pounds; it will be followed shortly by a pamphlet illustrating locomotives of this type weighing more than 175,000 pounds. The present pamphlet opens with a description of the 2-8-0 type, giving its distinguishing characteristics and special advantages for heavy freight service, or service on light rails where the wheel load is limited. The principal dimensions of thirty consolidation locomotives ranging in weights from 66,000 to 175,000 pounds are given; the tables being arranged in order of weights. Side elevation and end elevation drawings of the typical design are shown and the remainder of the pamphlet is taken up with halftones of the thirty locomotives mentioned in the tables. This pamphlet is the third of a series to be issued by the company and which will include all the standard types of locomotives and constitute a record of its production. Copies of the pamphlet already issued on the Atlantic, Pacific and Consolidation types may be had upon request.

MANUFACTURERS' NOTES.

The Whitman & Barnes Mfg. Co., Chicago, Ill., announce the removal of their New York office from 111 Chambers Street to 59 Center Street.

The Whitney Mfg. Co., Hartford, Conn., are making unusual preparations for 1907, having in process new methods, new machinery, and a new modern fire-proof factory building.

The Jeffrey Manufacturing Co., Columbus, Ohio, have established a new Canadian branch office in Montreal, Canada, at Lagauchetiere and Coté Streets.

The Von Wyck Machine Tool Co., Cincinnati, O., lathe manufacturers, are erecting a large addition to their plant which will enable them to more than double their present output.

The firm of Maris Bros., 56th Street and Gray's Avenue, Philadelphia, Pa., consisting of Frank Maris, Charles E. Maris, and M. B. M. Tatum, was dissolved October 1, 1906. The firm will be continued by Frank Maris and Charles R. Maris.

Latshaw Pressed Steel and Pulley Co., Pittsburg, Pa., announce that they have appointed Henry J. McCoy Co. distributors for New York City, Chas. E. Ring & Co. for Brooklyn, R. Gray, Jr., Inc., for Newark.

The F. H. Bultman Co. announce the purchase by them of the plant and business of Mr. F. H. Bultman. All correspondence, invoices, statements of accounts, etc., should be addressed to the company at 2108 Superior Avenue Viaduct, Cleveland, Ohio.

The Patterson Tool and Supply Co., Dayton, Ohio, on account of their growing trade in Indiana, have located their Mr. A. G. Schonacker at 508 E. Twenty-third Street, Indianapólis, and from this location are taking excellent care of their Indiana customers for machine tools and supplies.

L. H. Gilmer & Co., Philadelphia, Pa., dealers in endless belting, machinery and supplies, announce that they have opened an office at 302 Mooney Building, Buffalo, N. Y., in charge of G. W. Gilmer, Jr.; also an agency in Glasgow, Scotland, 209 St. Vincent Street, in charge of Mr. Wm. F. Reid.

The N. P. Bowsher Co., South Bend, Ind., recently had a city fire alarm box installed on the ground between their factory and lumber yards. This, in connection with the district patrol service and private hydrants, gives the Bowsher Co. protection not excelled by any other factory in the city.

The Gisholt Machine Co., 1316 Washington Avenue, Madison, Wis., which acquired the plant of the American Turret Lathe Co., Warren, Pa., about a year and a half ago, are operating the plant, building their 30- and 36-inch boring mills there at present. The plant has been in operation for something over a year and is now employing about 125 men.

The Fox Machine Co., Grand Rapids, Mich., report that their orders have for some time run far in excess of their capacity; this applies particularly to the Fox light milling machine. To keep up with their orders they have started a night crew, which together with the day work, means operating the shop twenty-two hours per day.

The Patterson Tool & Supply Co., Dayton, Ohio, have sold their lathe manufacturing business to Chamberlin & Evinger. The purchasers have formed a company composed of H. T. Chamberlin, E. R. Evinger and W. D. Foster. The firm will be known as the Miami Valley Machine Tool Co. Ground has been broken for a new factory building which the firm hopes to occupy by January 1st. Meanwhile they are building lathes in the old shop.

The Hide & Leather Association of New York City on Saturday, October 27, unveiled a historical tablet in the wall of the Schieren Building at Ferry & Cliff Streets, New York. A luncheon was served to invited guests at the conclusion of the ceremony. The district where this building is located was the birthplace of the leather and tanning industry of the city, and the leather business is still centered in this section.

The Star Corundum Wheel Co., Ltd., Detroit, Mich., have recently closed contracts for a new factory building which will be erected on Cavalry Avenue and Wabash R. R., Detroit, Mich. The building will be 70 x 175 feet and will be constructed of reinforced concrete and made fireproof throughout. Power will be furnished by a three-phase electric motor and the plant will be equipped with up-to-date machinery throughout for the manufacture of abrasive wheels. Their line includes principally solid corundum wheels, the vitrified, silicate and elastic processes being employed.

The Independent Pneumatic Tool Co., First National Bank Building, Chicago, Ill., held its annual stockholders meeting September 10, 1906. Besides a new board of directors the following officers were elected for the ensuing year: James B. Brady, President; W. O. Jacquette, First Vice-President; J. D. Hurley, Second Vice-President; C. E. Eri son, Treasurer; A. B. Holmes, Secretary. The business of this firm has shown a phenomenal increase during the past year. The manufacturing plant is several months behind in its orders and a large increase in floor space of the factory has become necessary. A gratifying growth in the foreign demand has been reported.

The Electric Controller & Supply Co., Cleveland, Ohio, announce the opening of a Chicago office in the Merchants' Loan and Trust Building, 135 Adams Street, Chicago, Ill., with Mr. W. M. Connelly in charge. Mr. Connelly was connected with the electrical department of the Homestead works of the Carnegie Steel Co. for five years and resigned his position there to become electrical engineer of the Ensley plant of the Tennessee Coal, Iron and Railroad Co. at Birmingham, Ala., which position he held for three years and resigned to enter Central Station Work at Birmingham, Ala., and at Houston, Tex., where he organized and had charge of the sales department. Mr. Connelly enters upon his new duties fully equipped to take care of the interests of the Electric Controller & Supply Co. in the Chicago district.

The Standard Roller Bearing Co., Philadelphia, Pa., have purchased the entire plant and real estate of the Pennsylvania Iron Works Co., which adjoins the present property of the Standard Roller Bearing Co. By this purchase the company have acquired five factory buildings with a total of 110,000 square feet floor space and a plot 120 x 1,600 feet, all located on the main line of the Pennsylvania Railroad. Two hundred and fifty thousand dollars was paid for the property. The Standard Roller Bearing Co. are at present erecting the largest reinforced concrete building in Philadelphia; it is five stories in height and 100 x 120 feet on the ground. This building will be devoted exclusively to the manufacture of annular ball bearings, automobile axles, etc. Over 1,200 people are now employed and this number will shortly be increased to 1,800. When the alterations are completed in the Pennsylvania Iron Works property it is expected that over 3,000 will be employed.

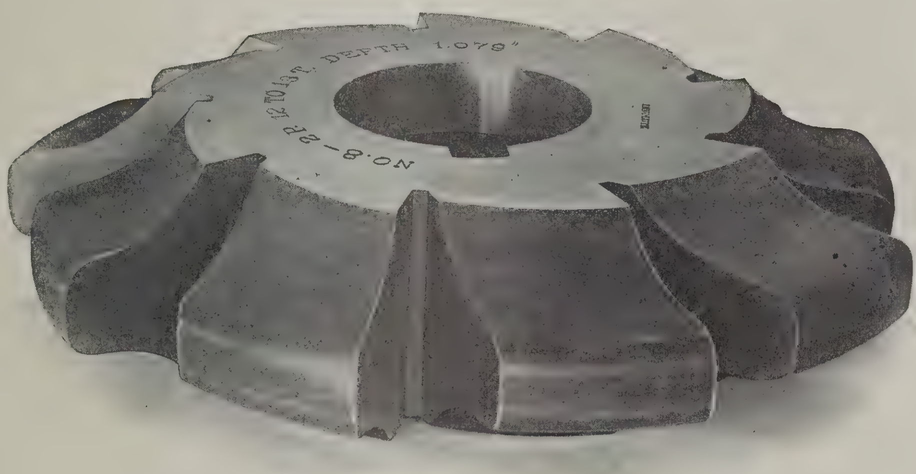
BROWN & SHARPE MFG. CO.

PROVIDENCE, RHODE ISLAND, U. S. A.

B. & S. Gear Cutters

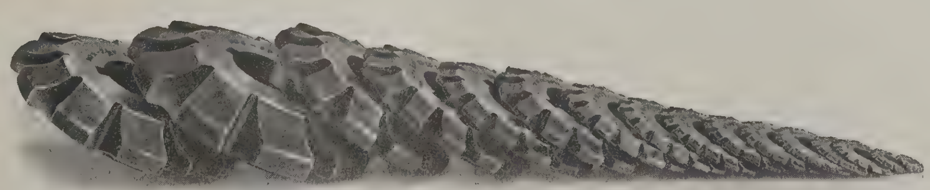
EMBODY THE CORRECT THEORY

THEY ARE LAID OUT FROM ORIGINAL CURVES



The forms are carefully laid out and maintained, the cutters being as nearly exact copies as expert mechanical skill, aided by special machines, can make them.

GEARS CUT WITH THESE CUTTERS ARE RECOGNIZED AS STANDARDS IN MODERN GEARING PRACTICE



CUTTER LIST MAILED ON APPLICATION

CONTENTS FOR NOVEMBER.

The contents of the November number of the *Century* are a delightful blend of facts, fiction and theory. A noteworthy feature is the first installment of Mrs. Frances Hodgson Burnett's new serial—"The Shuttle," a story the opening chapters of which give promise of Mrs. Burnett's best work. Mr. Mason's strong story, "Running Water," is continued, the plot growing more tangled and our interest even more firmly enlisted. There are numerous short stories; an article on Whistler, the artist; an interesting study of Julia Marlowe with portrait in tint. The first of a series of papers by Ellis Paxson Oberholtzer which will particularly interest American business men appears in this number; it is entitled "Jay Cooke and the Financiering of the Civil War" and is illustrated by reproductions from daguerreotypes, paintings, etc. "Mr. Bryan and Our Complex Social Order" is the title of a paper by Franklin H. Giddings discussing the same subjects taken up in Mr. Bryan's Essay on Socialism which appeared in the *Century* of last April.

MISCELLANEOUS.

RAILWAY MACHINERY.

A special edition of MACHINERY devoted to Locomotive and Car Equipment and Mechanics.

December, 1906.

ELECTRICAL EQUIPMENT OF THE ERIE RAILROAD SHOPS AT HORNELL, N. Y.

The operation of machine tools by electric motors has an exceedingly wide field, but no class of manufacturing establishments exemplifies the adaptability of electric drive more than railroad shops. The large work handled necessitates extensive buildings and the use of great lengths of shafting and belting if power is transmitted mechanically from a central source. Rush repair jobs are frequent and require a great deal of overtime and Sunday work, when power requirements are small, as but sufficient machinery is operated to complete the particular work in hand. Mechanical transmission of power under such conditions is wasteful in the extreme, owing to the surplus power required to overcome the friction of shafting and belting throughout the shops. Where electric drive is used—either individual or group—a flexibility is obtained that cannot be secured by any other means, as it permits the use of a few machines independently, obviating the objectionable features enumerated and permitting operation with a minimum power-house capacity, thereby effecting a considerable saving in fuel.

There are many other considerations in connection with power transmission, one of the most prominent being the layout of the plant, which is especially important in a railroad shop, as it is generally made up of a number of separate buildings aside from the main machine and erecting shop, such as boiler shop, carpenter shop, tank shop, blacksmith shop, pipe shop, etc.—which are necessarily scattered, widely distributing the power requirements and necessitating the use of a number of prime movers. Where engines are used, steam is supplied either from a central boiler plant or by individual boilers forming a combination unit with the engine. The former arrangement is exceedingly poor from an economical standpoint owing to the low efficiency resulting from the usual excessive condensation which takes place in long lengths of steam pipe. Either method involves the expenses of skilled attendants, which amounts to a considerable sum annually. These conditions are, however, rapidly changing; electric motors are superseding steam equipments and have many times proved that they fulfill all requirements—reducing operating expenses, requiring a very small amount of attention, providing power that is perfectly reliable, and reducing the time of starting and stopping and changing speed to a minimum.

Other applications may be found in cranes and in transfer and turn-tables where the electric motor is superior to every other motive power, owing to its ease of control, efficiency and reliability.

It was these considerations that led the Erie Railroad Com-

Fig. 1. Interior of Power House.

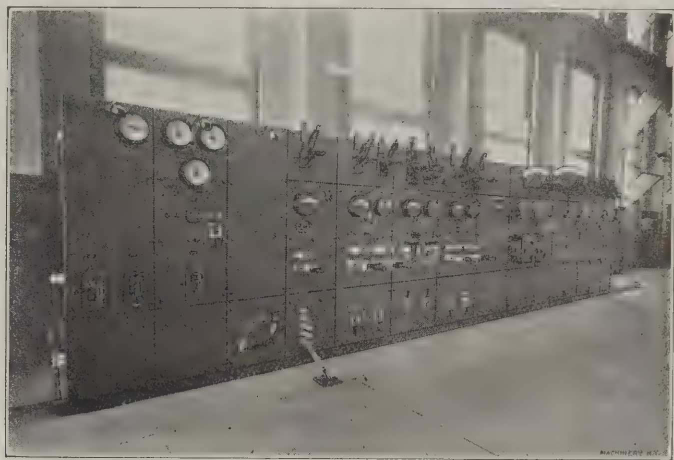


Fig. 2. Switchboard.

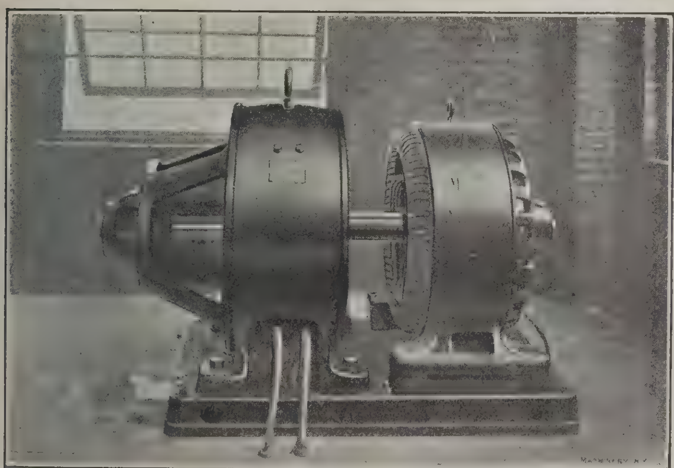


Fig. 3. Motor Generator set for Yard and Depot Lights.

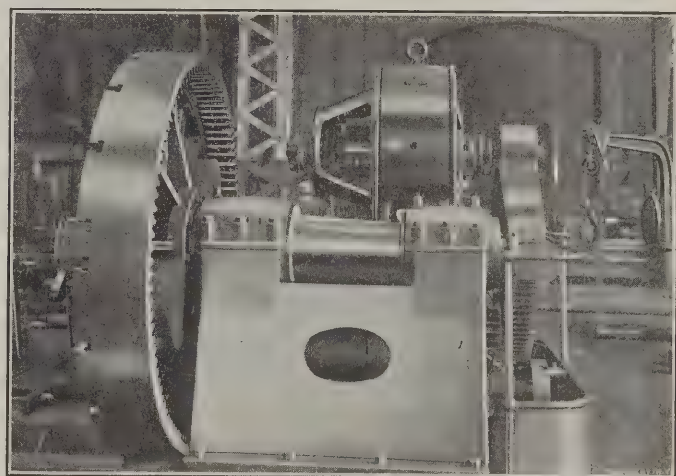


Fig. 4. Forty H. P. Motor Operating Niles Driving Wheel Lathe.

pany to abandon mechanical transmission of power and adopt the electrical drive at its Hornell shops, which now utilize electric power entirely and furnish an excellent example of the expediency and use of both individual and group drive.

When the present management took charge of the Erie Railroad it adopted broad and comprehensive plans for the development of the entire property, which are rapidly making it one of the most modern and efficient railway systems in the country. These plans embraced extensive alterations and additions to the many shops of the system in order to enable them to respond rapidly and efficiently to the increasing demands made upon them by the necessary additions to the rolling equipment.

New shop buildings and roundhouses have been constructed, old machines replaced by new, an efficient shop organization effected and the entire mechanical department brought up to a high standard of efficiency. This work under the direction of Mr. E. A. Williams, general mechanical superintendent, and Mr. G. W. Wildin, mechanical superintendent, has been carried on at many different points on the system, but the most extensive single installation of modern shop equipment is at the Hornell shops located at Hornell (Hornellsville), N. Y. At this point new buildings have been erected, additions made to old buildings, a new power house erected and a large number working shop in existence, therefore it was finally resolved to make the installation consist entirely of direct current apparatus with the exception of a small generator set which is used to supply the current necessary for the present yard and depot lights. This installation is an excellent illustration of the principle that each railroad shop must be considered as a separate and independent problem, and it is impossible to lay down any hard and fast rules which can be taken as guides, but that each particular case must be thoroughly investigated and a final decision reached in conformity with the conditions existing at that point.

As indicated above, the enlargement of the power house at some future time has not only been contemplated, but provided for. The type of apparatus to be placed in the engine room, however, will be determined upon at the time of making the addition, as the present system can readily be expanded in either of two ways. Additional power can be obtained by the installation of the necessary capacity, either in an alternating current generator which would supply the lines direct, the present motor generator set acting as a tie between the present units and the future one, or a direct current generator, with the necessary transforming apparatus for alternating current, can be installed if it is found that conditions demand that this be done.

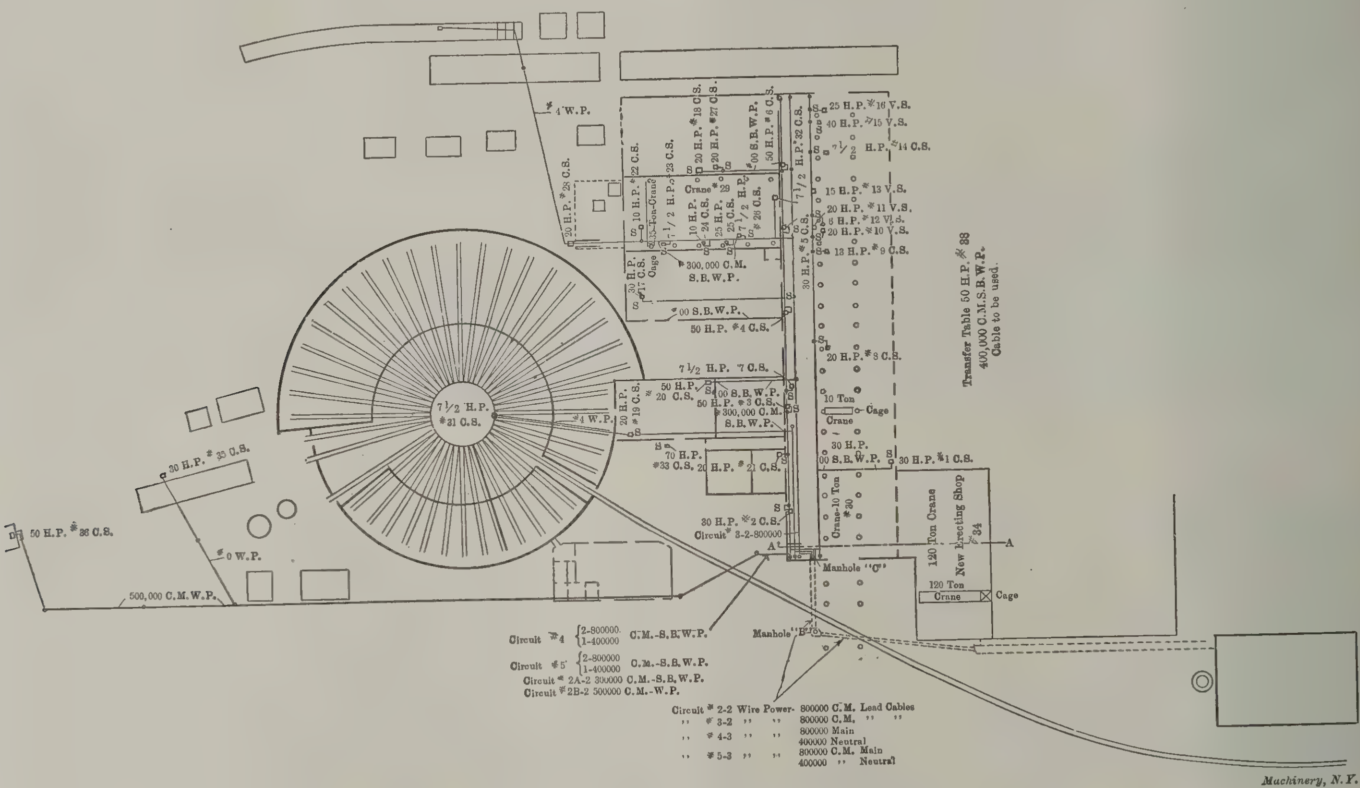


Fig. 5. Shop and Circuit Layout, Erie Railroad Shops, Hornell, N. Y.

of new machine tools, with a complete system of electric drive, installed. This installation is an interesting and instructive illustration of the latest engineering practice for a railway shop where the largest proportion of power is required at short distances from the power house and a large amount of variation in speed and crane loads occurs.

Before making a final decision as to the type of electrical apparatus to be installed, a careful comparison was made relative to the advantages and disadvantages of both the alternating current and direct current types of apparatus for the service contemplated. This analysis included not only the motors themselves, but also the various accessories, such as wiring, controllers, etc. Due consideration was also given to an installation involving the use of both alternating and direct current motors, but while it appeared probable that at some time in the future, an equipment of this nature would be necessary, it was decided that present conditions do not justify the installation of both types of motors. Under the conditions existing at Hornell, it is apparent that all of the motors are located well within the limits of 220 volts distribution, and in addition that there is at this time no wood-

The power house is a large brick structure of fireproof construction, with concrete roof and flooring, and has ample provision for light and ventilation. The building is large enough to provide for future extensions, foundations already being in place for doubling the boiler capacity so that it is only necessary to erect the additional units. The interior of the power house, showing the engines and generators, is shown in Fig. 1. The boiler plant consists of four Babcock & Wilcox units of 400 horse-power, operating at 150 pounds pressure and equipped with chain grates. All live steam mains are provided with the Holley drip system. The coal handling and stoking is especially interesting as, from the time the coal is dumped from the cars until it is fed into the furnace, it is conveyed automatically. The coal passes from the car into a chute which empties into a crusher, and is then conveyed by an endless belt to the top of the power house, where it passes through another chute to the second conveyor that distributes it in the bunkers over the boiler room. From there the coal passes through chutes to hoppers in front of the furnaces, where it is fed into the chain grates. The amount of coal admitted into the hoppers is controlled in the boiler room by

means of levers. The conveyors, which were manufactured by the Exeter Machine Company, have a capacity of 60 tons per hour and are operated by a 10 horse-power and a 13½ horse-power Westinghouse type S motor. The coal crusher is operated by a 20 horse-power type S motor.

The generating equipment consists of three Ball & Wood cross-compound, high-speed condensing engines, two of 500 horse-power each, direct connected to two Westinghouse 300 kilowatt, direct current, 250-volt, 3-wire generators running at 150 revolutions per minute, and one of 400 horse-power direct connected to a similar generator of 200 kilowatts capacity operating at 200 revolutions per minute. The engines run condensing except in cold weather, when the exhaust steam is utilized in heating the shops. Water for condensing purposes is stored in a large well which derives its supply from a small river near the power house.

F oil switches. Mounted upon the motor panel is a circuit breaker, an ammeter, a field rheostat and a motor-starting switch. The three generator panels are provided with the usual apparatus for a three-wire installation. The load panel is equipped with two switchboard type integrating wattmeters, two ammeters and two voltmeters.

The six feeder panels control six circuits as follows: Circuit No. 1—New erecting shop, 120-ton crane and transfer table. Circuit No. 2—Carpenter shop, blacksmith shop, new boiler shop and tank shop motors. Circuit No. 3—Roundhouse turntable, machine shop, coal pocket and ash-pit motors. Circuit No. 4—All lineshaft motors. Circuit No. 5—Individual drive motors. Circuit No. 6—Motors in power house for coal conveying apparatus. Each feeder panel is also provided with switches for controlling the various lighting circuits.

Current is transmitted by cables through a large tunnel to

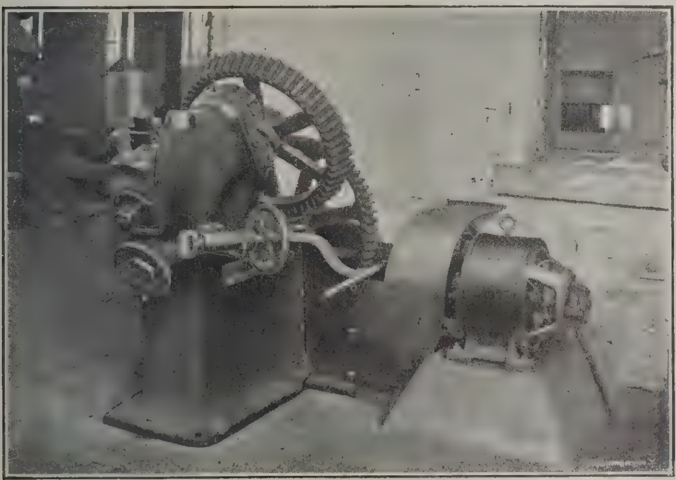


Fig. 6. Seven and a Half H.P. Motor Operating Lennox Bevel Shear.

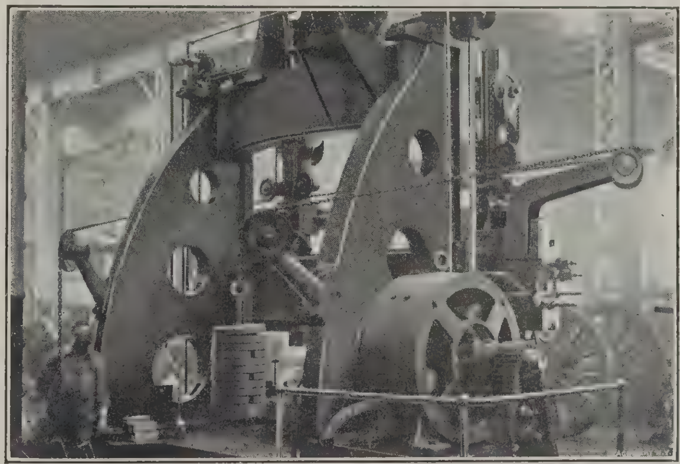


Fig. 7. Niles 90-inch Boring Mill Driven by 20 H. P. Motor.

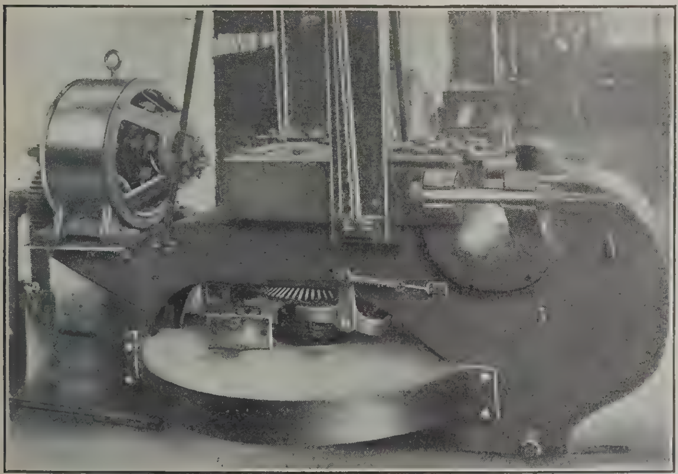


Fig. 8. Ten H. P. Motor on Horizontal Punch.

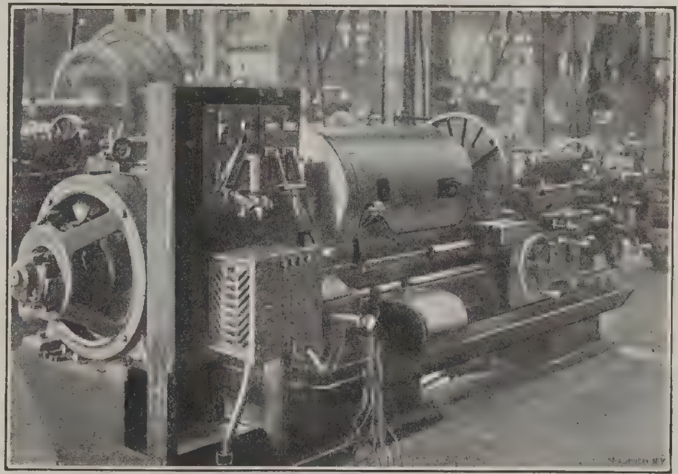


Fig. 9. Engine-lathe used for Crankpin Work, Driven by 7 1-2 H.P. Motor.

Besides the generating equipment and pumps there are two Ingersoll-Sergeant compound air compressors that furnish compressed air to the pneumatic hammers in the shops.

Fig. 3 illustrates a motor-generator set which supplies current for the yard and depot lights. It consists of a 115 horse-power Westinghouse type S motor direct connected to a 75 kilowatt, Westinghouse 2-phase, 60-cycle, 1,040 volt revolving field alternator operating at 900 revolutions per minute.

A standard Westinghouse switchboard, shown in Fig. 2, is provided with motor-generator panels, direct-current generator panels, feeder panels and a load panel and two blank panels providing for future extensions.

There are three motor-generator panels, two alternating-current and one direct-current or motor panel. The alternating-current generator panel is provided with one indicating wattmeter, one ammeter, one voltmeter, one type F oil switch, a rheostat, and the usual smaller instruments. The feeder panel is equipped with one power factor meter and two type

the new erecting shop and thence through underground conduits to the various buildings. The Westinghouse three-wire system of distribution is used for lighting and power, with an electro-motive force of 250 volts between outside wires, and 125 volts between each outside wire and neutral. There is a decided advantage in the flexibility of the voltage as incandescent and Cooper Hewitt lamps are operated on the 125-volt sides of the system and constant-speed 250-volt motors are connected to the main or outside wires while the variable speed motors utilize shunt field control.

Fig. 5 is a plan of the shops and gives the location of the various motors. It is particularly interesting as it shows the great diversity of motor applications.

The old erecting shop utilizes both group and individual drive, the group driven machines being divided into five sections and operated by five type S constant-speed motors, two of 30 horse-power capacity and three of 50 horse-power capacity. The machines in the fitting shop, which occupies one wing of

the erecting shop, are also group driven by a Westinghouse 30 horse-power, constant speed, type S motor. A complete list of the machine tools operated in each section is given below:

Section 1—50 Horse-power, Constant Speed Westinghouse Type S Motor.

Wheel press, 100 tons capacity.	53-in. vertical boring mill.
Wheel press, 300 tons capacity.	42-in. vertical boring mill.
Car wheel borer.	37-in. vertical boring mill.
Double car axle lathe.	36-in. upright drill.
Single car axle lathe.	28-in. upright drill.
4-spindle drill.	24-in. pillar shaper.
Horizontal boring machine.	32x32-in. x 8-ft. planer.
24-in. engine lathe.	1½x24-in. turret lathe.
80-in. driving wheel lathe.	90-in. quartering machine.
Two 16-in. engine lathes.	Duplex emery grinder.
18-in. engine lathe.	7-Spindle nut tapper.
15-in. engine lathe.	40-in. upright drill.
10-in. slotter.	Small flange punch.
No. 4 plain milling machine.	

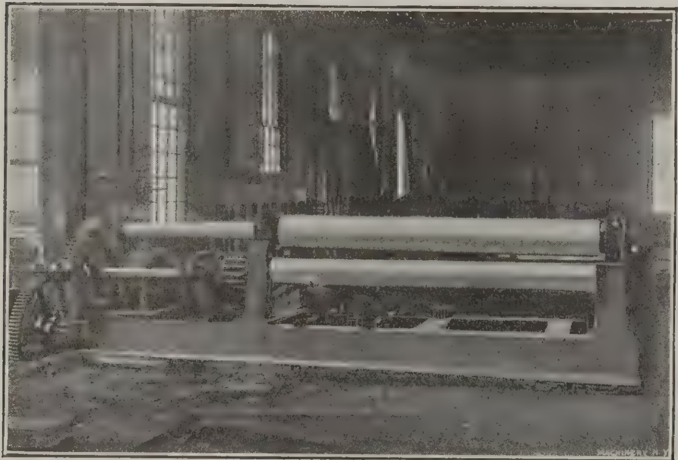


Fig. 10. Plate Rolls Operated by 10 H.P. and 15 H.P. Motors.

Section 2—30 H.P., Constant Speed, Westinghouse Type S Motor.

Two 16-in. engine lathes.	12-in. slotter.
1½-in. bolt pointer.	2-spindle centering machine.
60x60-in. x 19-ft. planer.	Slab milling machine.
5-ft. radial drill.	40-in. drilling, facing and tapping machine.
4-ft. radial drill.	Duplex emery grinder.
18-in. slotter.	Triple head slotter.
Two 2-in. double bolt cutters.	40-in. upright drill.
1½-in. staybolt cutter.	

Section 3—50 H.P., Constant Speed, Westinghouse Type S Motor.

42x42-in. x 18-ft. planer.	Horizontal boring machine.
Ring turret lathe.	14-in. engine lathe.
48-in. upright drill.	Two 16-in. engine lathes.
42-in. engine lathe.	42-in. vertical boring machine.
30-in. engine lathe.	40-in. upright drill.
24-in. engine lathe.	32x32-in. x 8-ft. planer.
Crank planer, 20x20-in. x 24-ft.	5-ft. radial drill.
2x26-in. turret lathe.	Double-head traverse shaper.
36-in. engine lathe.	No. 4 plain milling machine.
36-in. engine lathe.	26-in. engine lathe.
Horizontal boring machine.	30-in. engine lathe.

Section 4—50 H.P., Constant Speed, Westinghouse Type S Motor.

16-in. engine lathe.	No. 17 Landis grinding machine.
24-in. engine lathe.	42-in. vertical boring machine.
24-in. pillar shaper.	36-in. upright drill.
Friction drill.	28-in. upright drill.
36x36-in. x 10-ft. planer.	48-in. upright drill.
36x36-in. x 8-ft. planer.	36-in. engine lathe.
32x32-in. x 8-ft. planer.	30-in. engine lathe.
20-in. engine lathe.	2—Fox turret lathes.
18-in. engine lathe.	86-in. vertical boring machine.
16-in. engine lathe.	Duplex emery grinder.
24-in. engine lathe	
Cylinder boring machine.	

Section 5—30 H.P., Constant Speed, Westinghouse Type S Motor.

2x26-in. turret lathe.	Key-slot milling machine.
20-in. American brass lathe.	30-in. engine lathe (piston rods).
24-in. engine lathe.	36x36-in. x 10-ft. planer.
18-in. slotter.	

Fitting Shop—30 H.P., Constant Speed, Westinghouse Type S Motor.

28-in. upright drill.	40-in. upright drill.
30-ton arbor press.	15-ton arbor press.
36x36-in. x 8-ft. planer.	2-spindle centering machine.
37-in. vertical boring machine.	Buffing wheel.
Three 18-in. engine lathes.	Small emery grinder.
Two 16-in. engine lathes.	Surface grinder.
30-in. engine lathe.	Guide grinder.
11-in. bench speed lathe.	Polishing tape and wheel.
24-in. pillar shaper.	Swing grinder.
20x20-in. x 24-ft. crank planer.	Friction drill.

In addition to the group driven machines in the erecting shop, there are a number of individually driven machines operated by both constant and variable speed Westinghouse type S motors, as follows:

Constant Speed Motor-driven Machines.

One 20-horse-power motor driving a planer.
One 13-horse-power motor direct connected to 600-ton wheel press.
One 7½-horse-power motor for moving tail-stock of driving wheel lathe.

Variable Speed Motor-driven Machines.

One 7½-horse-power motor operating vertical miller for side rods.
One 20-horse-power and one 6-horse-power motor operating 90-inch boring mill.
One 20-horse-power motor operating driving axle lathe.
One 7½-hores-power motor operating crankpin lathe.
One 40-horse-power motor operating 90-inch driving wheel lathe.
One 25-horse-power motor driving truck tire lathe.

The list of Westinghouse type S variable speed motors and the machines they drive is a typical illustration of their application and a practical demonstration of their ability to increase output, as the time and labor necessary to shift belts or change mechanical speed devices is minimized, and a piece of work can be machined continuously from the smallest to the largest diameter without interruption.

The speed of these motors is controlled by varying the field strength, and, as this may be done while the machine is in operation, it affords an easy and convenient method of speed regulation always under the immediate control of the operator, the controller being conveniently placed within his reach. The variation of field strength is effected by means of a resistance placed in the shunt field circuit of the motor, which decreases the shunt field current and causes a decrease

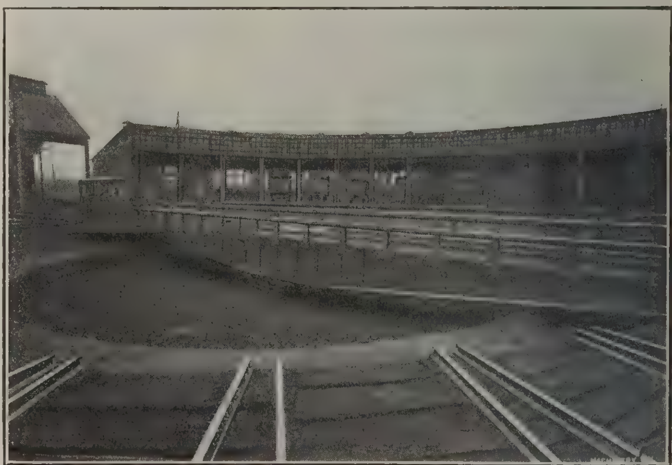


Fig. 11 Turntable Driven by 7 1-2 H.P. Motor.

in the field strength and an increase in speed, producing an extremely simple and effective means of varying the speed of either a shunt or a compound-wound motor.

One of the most prominent characteristics of this method of control is the simplicity and low cost of control apparatus made possible by the extremely small current which is handled. A second marked characteristic is the increase of speed with decrease of torque, when used as an adjustable speed motor, the horse-power output remaining practically constant throughout the whole speed range, which makes it peculiarly adapted to machine tool driving. This system involves the use of a minimum amount of auxiliary apparatus, thus materially reducing the first cost of an installation. The regulation of motors operating by shunt field control is good, which is of special importance in the operation of machine tools and in service of any class where constant speed is de-

sirable and where the torque varies between wide limits. The efficiency of motors operating at variable speeds remains practically constant over the range of speed.

Having considered the erecting shop equipment, the smaller shops next receive attention, the motors and the machine tools they operate in each department being given in their respective places.

Tool Room—20 H.P., Constant Speed, Westinghouse Type S Motor.

Yankee twist drill grinder.	15x15-in. x 20-ft. crank planer.
Duplex emery grinder (8-in. wheels).	16-in. toolroom lathe.
No. 4 Universal milling machine (Brown & Sharpe).	No. 3 Landis universal grinding machine.
No. 4 Universal Milling Machine (Cincinnati Milling Machine).	Sellers tool grinder.
	Reamer and cutter grinder.
	Gardner disk grinder.

Carpenter Shop—50 H.P., Constant Speed, Westinghouse Type S Motor.

Hollow chisel mortiser and boring machine.	12-in. rip saw.
Gaining machine.	42-in. band saw.
2-spindle shaper.	12-in. cutting-off saw.
Molding machine.	Single horizontal borer.
24 x 14-in. x 9-ft. Daniels' planer.	Tenoning machine.
Plain mortiser and borer.	15-in. turning lathe.
8x14-in. planer, 3 cutters.	15-in. swing vertical borer.
18-in. rip saw.	4-in. pipe cutter.
	3-in. pipe cutter.

Blacksmith Shop—30 H.P., Constant Speed, Westinghouse Type S Motor.

2—Power hammers.	2½-in. bolt header.
Light bar shear.	Alligator shears.
Small bolt header.	Bar iron shears.
1½-in. bolt header.	Hot saw.

50-horse-power constant speed type S motor direct connected to No. 9 Sturtevant fan.

Round House Machine Shop—20 H.P., Constant Speed, Westinghouse Type S Motor.

16-in. engine lathe.	40-in. upright drill.
26-in. engine lathe.	Duplex emery grinder.
32x32-in. x 8-ft. planer.	15-ton arbor press.
24-in. pillar shaper.	

Miscellaneous Applications.

One 70-horse-power Westinghouse type S constant speed motor driving fan for round-house heating system.
One 10-horse-power Westinghouse type S constant speed motor driving fan for new erecting shop heating system.
One 7½-horse-power variable speed Westinghouse type S motor operating round house turntable.
One 50-horse-power constant speed motor operating coal conveyor in locomotive coaling station.
One 30-horse-power constant speed Westinghouse type S motor operating ash conveyor for removing ashes from locomotive ash-pit.
One 7½-horse-power Westinghouse motor operating alligator shears for cutting up sheet scrap. This installation is located at the scrap bins in the shop yards.
One 25-horse-power motor operating transfer table.

The preliminary studies and final report, showing the benefits which would be the result of electrically equipping these shops, were made by the Westinghouse Electric and Manufacturing Company in conjunction with the motive power department of the Erie Railroad Co. The results have more than borne out the promises made to the management.

The installation of the new electrical equipment presented many engineering problems, but the work of transformation was carried on without any interruption to the service, and it reflects great credit to the contractors, Westinghouse, Church, Kerr & Company, who installed the plant, and Mr. George T. Depue, master mechanic of the Erie Railroad Company, who has charge of the Hornell shops.

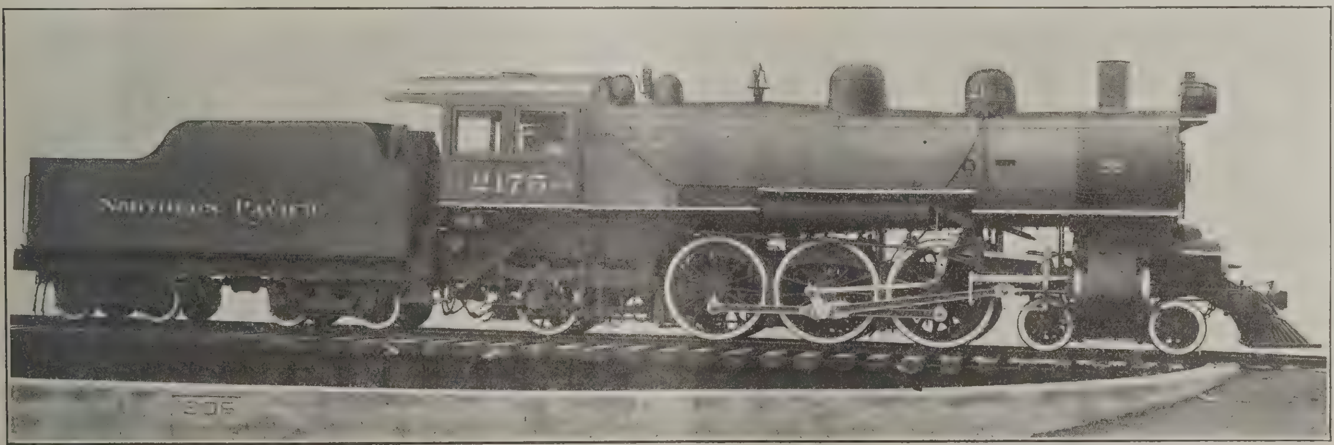


Fig. 1. Cole Four-cylinder Balanced Compound Locomotive for the Northern Pacific Railway, 40,000th Locomotive built by the American Locomotive Co.

Boiler Shop—7 1-2 H P., Constant Speed, Westinghouse Type S Motor.

Two Hartz flue welding machines.
Two flue cutting machines.

Direct-driven Machines Operated by Constant Speed, Westinghouse Type S Motors.

One 7½-horse-power motor driving 20-inch punch and shears.
One 25-horse-power motor operating plate rolls.
One 10-horse-power motor operating horizontal punch.
One 7½-horse-power motor driving bevel shears.
One 10-horse-power motor operating 36-inch punch and shears.

In connection with the boiler shop equipment there is a flue rattler which is located outside the building and is operated by a 20-horse-power type S motor. It is 48 inches in diameter and 22 feet long, and has a capacity of 175 to 200 flues. An average of five lots per day are cleaned, the exact time for each rattling depending upon the water used in the boilers. The longest flue is 21 feet, and they vary from 1½ to 2½ inches in diameter.

Tank Shop—20 H.P., Constant Speed, Westinghouse Type S Motor.

36-inch single shear.	36-inch single punch.

In addition to the belt-driven machines there is a 10-horse-power and a 15-horse-power constant speed type S motor geared to plate rolls.

COLE FOUR-CYLINDER BALANCED COMPOUND LOCOMOTIVE FOR THE NORTHERN PACIFIC RAILWAY.

A party of editors and newspaper men in company with Mr. G. M. Basford of the American Locomotive Co. visited their Schenectady Works, November 2, to inspect a Cole four-cylinder balanced compound Pacific (4—6—2) type locomotive built for the Northern Pacific Railway, which has the distinction of being the company's 40,000th locomotive. This number includes the total output of all the constituent companies now owned and controlled by the American Locomotive Co., namely: Schenectady Locomotive Works, Schenectady, N. Y.; Brooks Locomotive Works, Dunkirk, N. Y.; Pittsburg Locomotive Works, Pittsburg, Pa.; Rhode Island Locomotive Works, Providence, R. I.; Richmond Locomotive Works, Richmond, Va.; Rogers Locomotive Works, Paterson, N. J.; Dickson Locomotive Works, Scranton, Pa.; Locomotive & Machine Co., Montreal, Canada; Cooke Locomotive Works, Paterson, N. J.; Manchester Locomotive Works, Manchester N. H. The oldest company represented is the Rogers Locomotive Works, founded in 1831 to build cotton, woolen and flax machinery. The first locomotive built by Rogers was the *Sandusky*, for the Mad River & Lake Erie R. R. Co., in 1837.

The 40,000th locomotive is one of an order for two of this

type. (See RAILWAY MACHINERY, June, 1904.) It combines the latest and most important development in locomotive design in this country, but no untried features. The important features are the four balanced compound cylinders, boiler with combustion chamber, and Walschaerts valve gear.

The arrangement of cylinders employed in the application of the balanced and divided principle is the Cole type with the high-pressure cylinders ahead of the low-pressure and, in this case, inclined at a slight angle (about 4 degrees) so as to clear the leading truck. The location of the high-pressure length of high-pressure connecting-rod of 91¼ inches was obtained.

Inclining the high-pressure cylinder avoids the difficulty inherent with four-cylinders in the same transverse plane on this type of locomotive. It would otherwise have been necessary in order to get a good length of high-pressure connecting-rod to either increase the distance between the center of the cylinder and the forward driving wheels 30 to 36 inches, involving a similar increase in the length of boiler and tubes or to make use of the bifurcated design of high-pressure con-

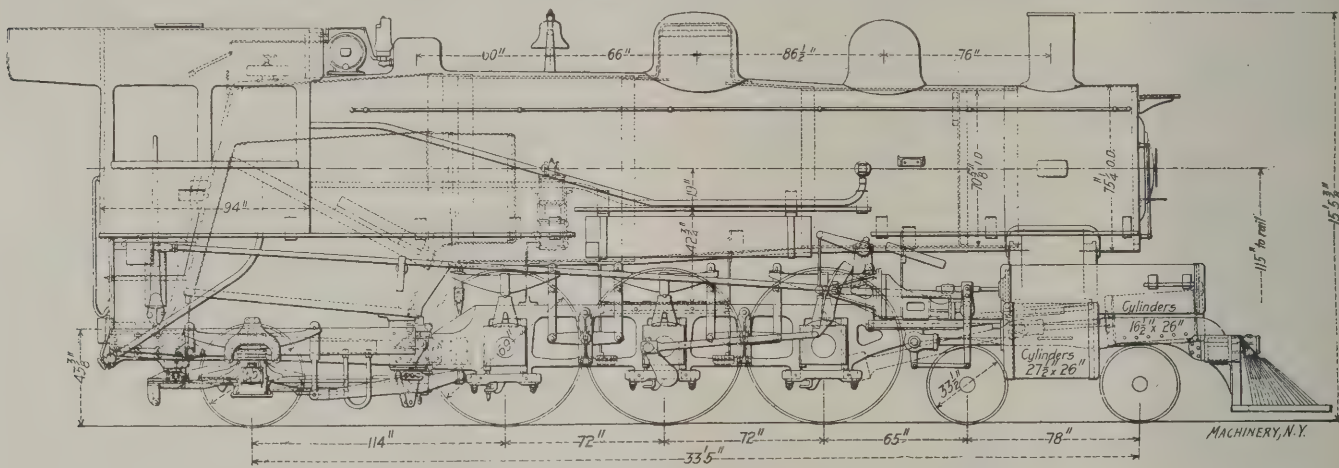


Fig. 2 Side Elevation of Cole Four-cylinder Balanced Compound Locomotive.

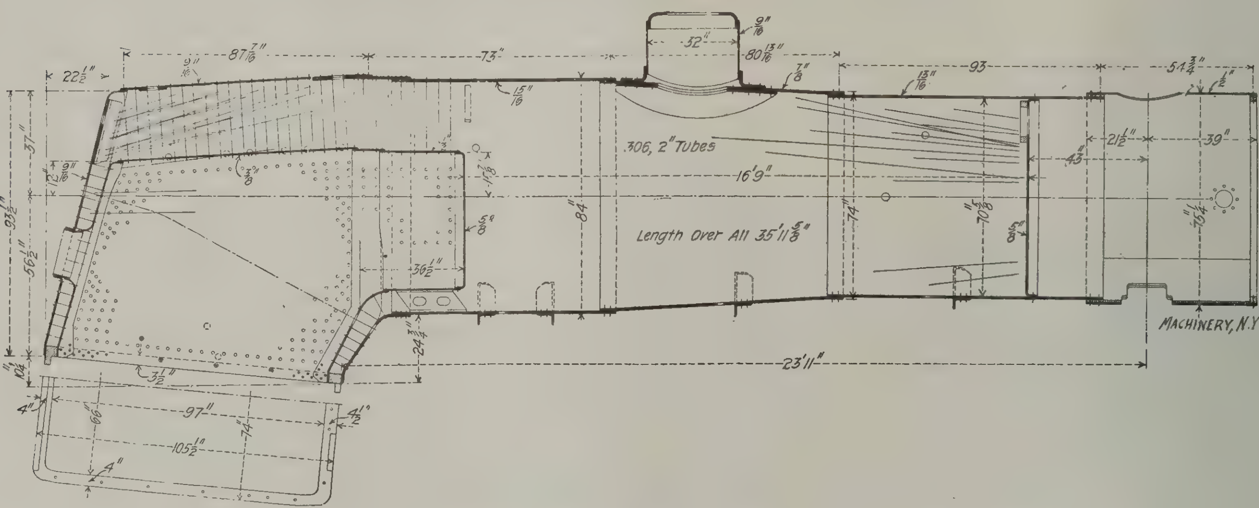


Fig 3. Boiler of Cole Four-cylinder Balanced Compound Locomotive, with Combustion Chamber.

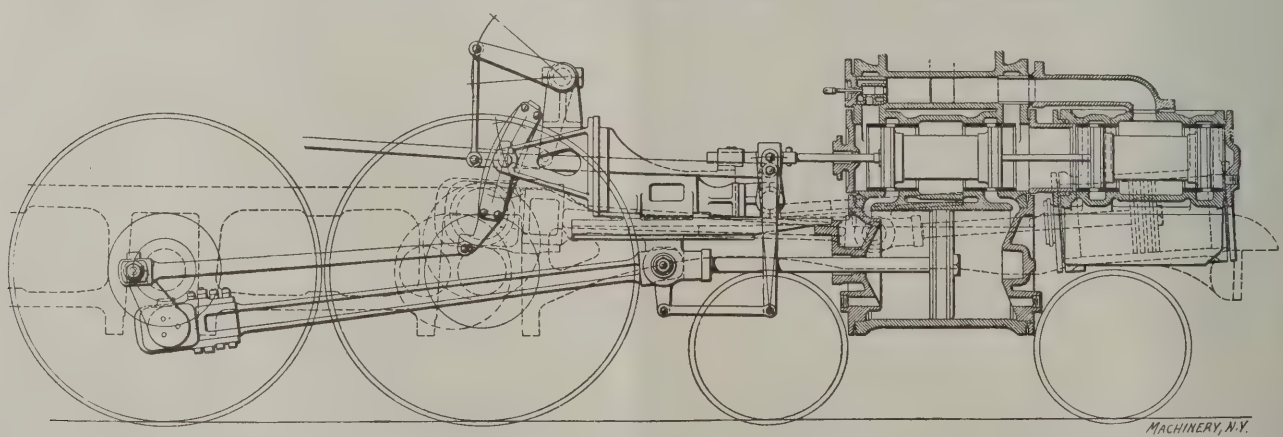


Fig. 4 Walschaerts Valve Gear, and Section through Low-pressure Cylinder and Valve Chamber.

cylinders ahead of the low-pressure cylinders is for the purpose of getting sufficient length for high-pressure connecting-rod to permit of its connection to the forward axle. The outside or low-pressure cylinders are connected to the middle axle and thus the application of the power developed in the four cylinders is distributed between two axles. By increasing the distance between the center of the cylinders and the forward driving axles 12 inches and extending the front end of the boiler, keeping the length of the flues the same as in the simple Pacific engine without combustion chamber, a necting-rod straddling the front axle. It is desirable to avoid the latter alternative on account of the weight and cost of such construction and its inaccessibility in case of repairs, and, as just pointed out, it is considered better to divide the power between two axles rather than to confine it to one.

The purchasing of a balanced compound locomotive by the Northern Pacific Railway is considered as being further evidence of the confidence of railroads of this country in the advantages of this design of the balanced type. These briefly are as follows: The approximately perfect balance of the recipro-

cating parts combined with the perfect balance of the revolving weights; permissible increase of weights on driving wheels on account of elimination of hammer-blow; increase in sustained horse-power at high speeds without modification of the boiler; sub-division of power between four cylinders and between two axles; reduction of bending stresses on the crank axle due to the fact that only half the turning moment is transmitted through each axle; light moving parts which will minimize wear and repairs.

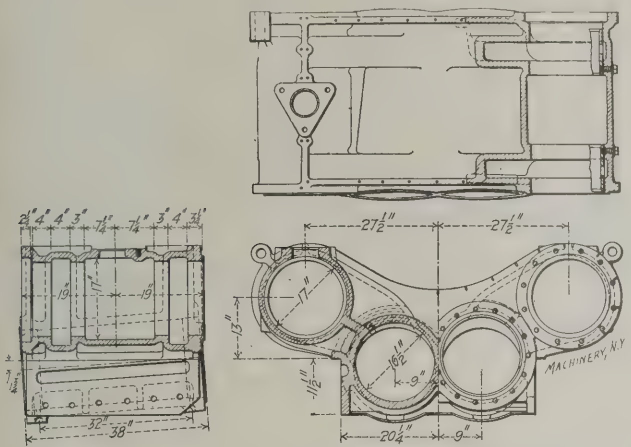


Fig. 5. Cross-section of High-pressure Cylinder and Valve Chamber.

In this present example the increase of weight on the driving wheels on account of the elimination of the hammer-blow is 11,000 pounds over that of the Northern Pacific simple engines. As to sustained horse-power, tests taken on the New York Central four-cylinder balanced compound Atlantic type locomotives at the Louisiana Purchase exposition showed that with identically the same size of boiler a compound engine developed from 20 to 30 per cent greater horse-power at high speed than the original simple engine. In actual service the compound engine developed 1,688 I. H. P. at 57 miles per hour, and 1,980 I. H. P. at 75 miles per hour, while the original simple engine developed only from 1,400 to 1,500 I. H. P.

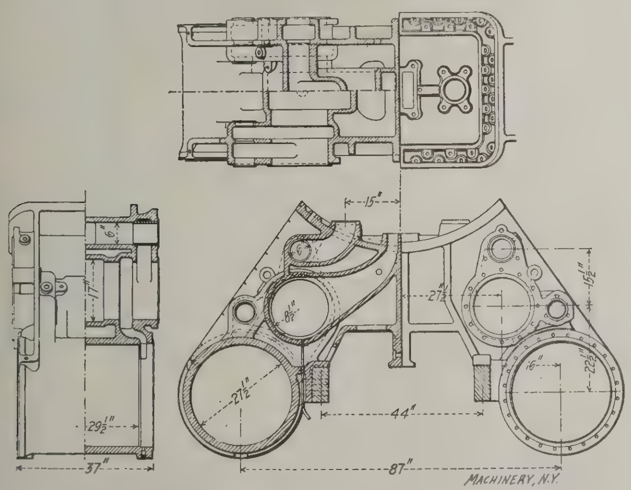


Fig. 6. Cross-section of Low-pressure Cylinder and Valve Chamber.

This locomotive is interesting also in that it contains a combustion chamber and is in line with the trend of practice on the Northern Pacific where the use of the combustion chamber has been found to reduce boiler troubles. The Northern Pacific Co. have recently had 70 locomotives built with combustion chambers, these being illustrated in RAILWAY MACHINERY in the September issue. The reduction in boiler troubles is attributed to the fact that the ends of the flues being removed from the hottest part of the fire, flue leakage is minimized. The combustion chamber also gives ample room to work on the flues without removing the brick arch and this means a saving in money and time. The fact that this construction does permit of flue work being done without affecting the brick arch is more advantageous in more ways than one. The brick arch, as everyone knows, is a promotor of good combustion but its use on locomotives has been discouraged as it is very expensive to maintain, if it must be removed every time the lower flues need attention. Hence it might be said that the combustion chamber makes the brick arch a practical feature of modern locomotive construction. The combustion chamber also materially increases the heating surface of the firebox and gives an increased firebox volume, which tends toward better combustion. Although the combustion chamber reduces the tube heating surface it is thought to be more than offset by the increase in firebox heating surface; a locomotive with a combustion chamber steams equally as well as a similar engine without a combustion chamber and with greater actual heating surface. A thorough trial of the combustion chamber on the Northern Pacific Railway has demonstrated the fact that where these conditions are found it greatly reduces boiler repairs and this we all know constitutes a large item in the cost of locomotive maintenance.

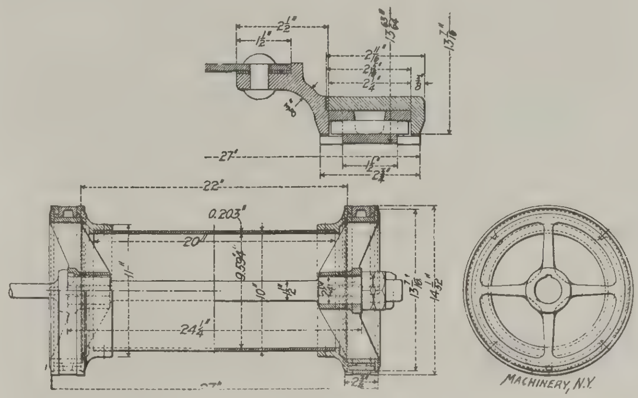


Fig. 7. Piston Valve with Boiler Tube Body.

As to the Walschaerts valve gear which is a prominent feature of this locomotive, this is now so widely introduced into American practice that it has ceased to be a novelty. Its practical advantages are conceded, and no doubt they will make it indispensable on large heavy locomotives of which this is an example. To review these advantages it may be stated as compared with the Stephenson link motion it is much more accessible for inspection, lubrication and repairs; it is lighter in construction; has less friction of parts; and affords a better opportunity than the Stephenson link motion for the introduction of strong frame bracing. This feature has been taken advantage of in the 40,000th locomotive. Not only is there a strong brace between the frames above the second axle but the frames are strongly tied together by a steel casting forward of the first axle. This casting is so constructed that it not only acts as a frame brace but it carries the rockers for the valve motion and also supports

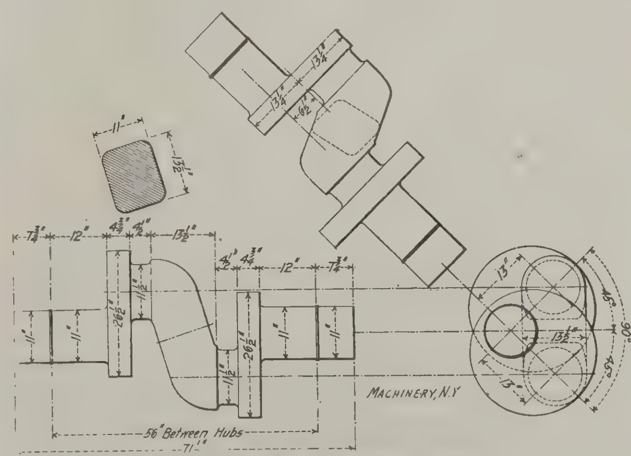


Fig. 8. Crank Axle, Forward Drivers.

the guides. A great deal of attention was given to the design of this feature and it is considerably of a novelty in American locomotive construction. Following are the principal dimensions of the locomotive:

Cylinders, compound piston valve; diameters, 16½ inches and 27½ inches; stroke, 26 inches; piston-rod diameter, 3¼ inches; piston packing, 2 cast iron snap rings.

Valves, type, piston; travel, 6 inches; steam lap, 1 inch; setting in lead, ¼ inch full front and back; exhaust clearance, high pressure, 5/16 inch; low pressure, ⅜ inch.

Gage, 4 feet 8½ inches; wheel-base, driving, 12 feet; rigid, 12 feet; total engine and tender, 62 feet 10 inches.
Weight in working order, 240,000 pounds; on drivers, 157,000 pounds; total engine and tender, 380,500 pounds.
Axles, driving journals, main, 11 x 11½ inches; others, 9½ x 12 inches; engine truck journals, diameter 6½ inches, length 12 inches; trailing truck journals, diameter 8 inches, length 14 inches; tender truck journals, diameter 5½ inches, length 10 inches.
Boxes, driving, main, cast steel; others, cast steel.
Boiler, type, extended wagon top; outside diameter first ring, 72¼ inches; working pressure, 220 pounds; fuel, bituminous coal.
Heating surface, tubes, 2,667.0 square feet; firebox, 232.9 square feet; arch tubes, 8.9 square feet; total, 2,908.8 square feet.
Firebox, type, wide; length, 96 inches; width, 65¼ inches.
Grate, style, rocking; grate area, 43.5 square feet; thickness of crown-sheet, ⅜ inch; tube-sheet, ⅝ inch; sides, ⅜ inch; back, ⅜ inch.
Water space: front, 4½ inches; sides, 4 inches; back, 4 inches.
Crown staying, radial.
Tubes: material, charcoal iron; number, 306; diameter, 2 inches; length, 16 feet 9 inches; gage, No. 11 B. W. G.
Exhaust pipe, single nozzles 5⅜, 5⅝, and 5⅞ inches.
Smokestack, diameter 18 and 20 7/16 inches; top above rail, 15 feet 5½ inches.
Brake, driver, Westinghouse-American combination; truck, Westinghouse-American combination; trailer, Westinghouse-American combination; tender, Westinghouse; air signal, Westinghouse J.; pump, 9½ inches R. H. on L. H. side; two reservoirs 18½ x 102 inches.
Tender, frame 13-inch channel steel; tank, style, water bottom; capacity, 7,000 gallons; fuel, 12 tons.
Wheels, driving diameter outside tire, 69 inches; centers, diameter, 62 inches; material, main, cast steel; others, cast steel; engine truck diameter, 33½ inches; kind, Standard Steel Works; trailing truck diameter 45 inches; kind, American Locomotive Co. cast steel spoke; tender truck diameter, 33½ inches; kind, Standard Steel Works cast iron plate.
Engine truck, 4-wheel swing center, wrought iron frame.

* * *

THE PINKUS RAILWAY—AN EARLY PNEUMATIC SCHEME.

A. R. BELL.

In the early days of railroad construction there were many attempts made to invent devices for propelling vehicles by mechanical means other than by steam locomotives. The atmospheric system was tried in 1847 and continued in use for about a year. The reason for it being discarded was, of course, due to the trouble and expense of working. The initial cost of equipment, however, was then claimed to be lower than ordinary rails with steam locomotives.

The means of propulsion consisted of a cylindrical tube, three feet in diameter, in which an air-tight piston moved, arranged midway between and a little below the level of the rails. The tube was laid the full length of the railway and had a smooth internal surface, the sections having air-tight joints. A stationary steam engine was used to pump a partial vacuum in the tube on one side of a piston, and the atmospheric pressure acting on the other side, pressed it forward and pulled the vehicle on the rails. As will be seen by the illustration the piston was not coupled direct to the passenger coach but to a trolley on the rails called a "dynamic traveler." This trolley served the purpose of raising and reseating the air-tight covering to the conduit as the piston progressed. At distances of about five miles along the

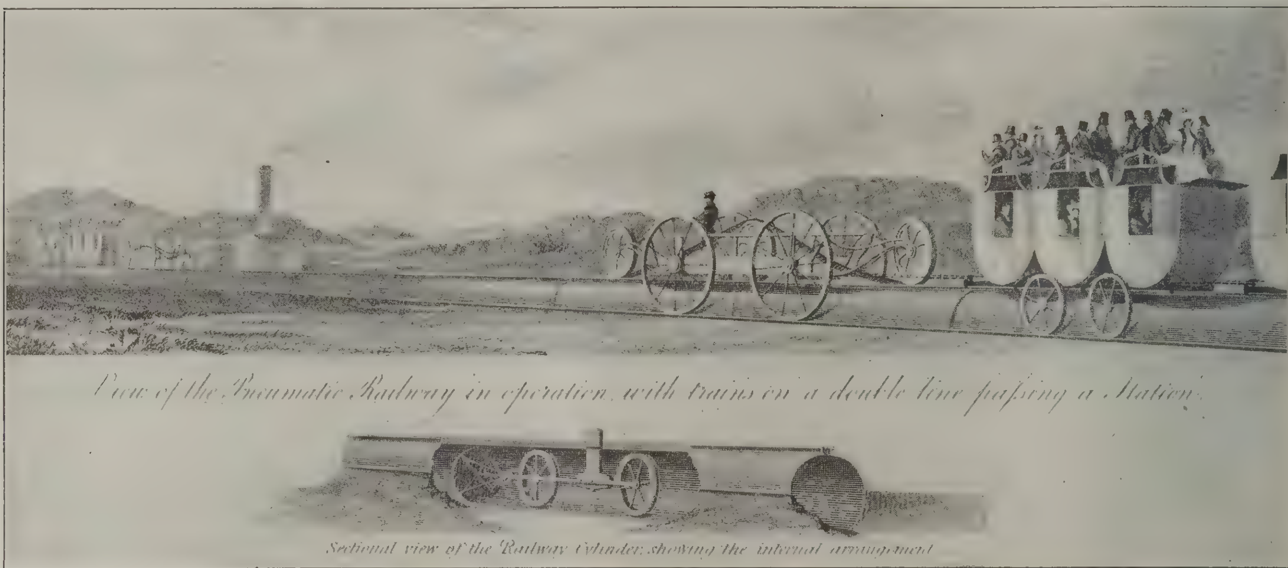


Fig. 1. Pinkus Pneumatic Railway in Operation, and Sectional View of the Cylinder—From an Old Print.

line, station valves were provided dividing the tube into sections so that more than one vehicle could be propelled along the same set of rails. For the purpose of checking the speed or stopping, an arrangement was devised for opening a valve in the piston, thus partly or fully destroying the vacuum in front of it. The continuous valve along the opening of the conduit was made of tarred felt, greased and rendered as flexible as possible in order to travel over the trolley wheels easily and form an effective air-tight joint.

* * *

We mentioned in the September, 1906, issue of RAILWAY MACHINERY that the number of locomotives equipped with Schmidt superheaters was 1,150. This figure was the number

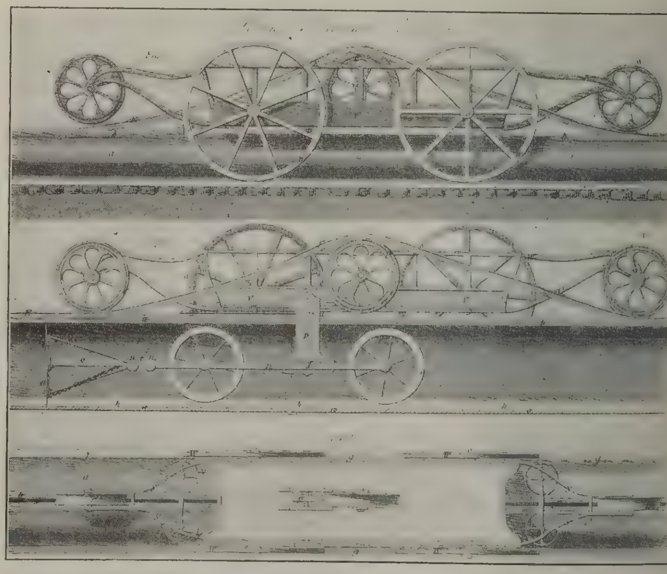


Fig. 2. Side Elevation, Side Section and Plan of the Pinkus Pneumatic Railway.—From an Old Print.

brought up to June, 1906. As an evidence of the rapid extension of this feature of improved locomotive boiler design it is of interest to know that under date of October 10 Mr. Schmidt informs us that the number of locomotives equipped and in the course of construction having the Schmidt superheater has increased to 1,664. Fifty-one railroads are now using it, mostly in Continental Europe.

SUB-PRESS WORK AT THE SLOAN & CHACE SHOPS.

The sub-press die is an old device dating back at least one and possibly two generations, and having its origin in watch and clock factories where its ability to perform blanking operations of the most delicate nature was early recognized and fully appreciated. That this tool, though familiar in the field just mentioned, has yet capabilities in other directions which have not hitherto been fully recognized, is the impression that must be strongly borne upon an appreciative mechanic who is acquainted with the work being done in the shops of the Sloan & Chace Manufacturing Co. of Newark, N. J. This firm has for many years built precision machinery for watch makers, fine tool makers and others, whose work requires great accuracy. It was over thirty years ago that they brought out their first line of bench lathes; their line now comprises, besides the lathes and the numerous attachments used on them, automatic pinion cutters, automatic gear cutters, drilling and tapping machines, bench milling machines, and many other tools of a more highly specialized nature, especially used in watch and clock making. Small sub-press dies had been built more or less from the beginning, but within the past few years this part of the business has been developed until it equals in importance the building of machinery.

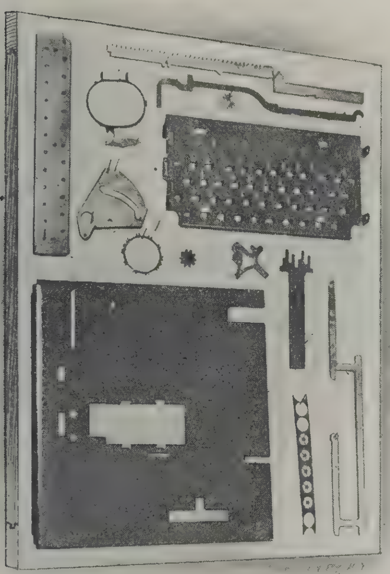


Fig. 1. Examples of Sub-press Work.

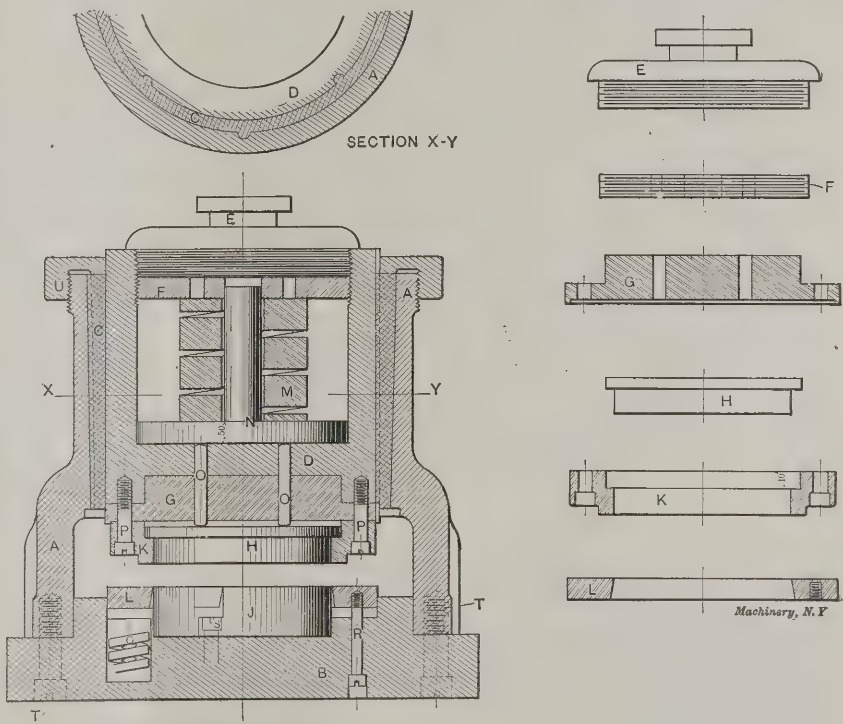


Fig. 2. Construction of Typical Sub-press.

A section of a typical blanking sub-press of the common cylindrical type is shown in Fig. 2. It is doubtless familiar to most toolmakers, so will need but a few words of description. To base *B* is screwed and dowelled the cylinder *A* lined with babbitt, as shown at *C*, this lining being provided with ribs which engage corresponding grooves in plunger *D* which works up and down within the babbitt lining under the action of the ram of the press in which it is used. Nut *U* furnishes an adjustment for tightening the babbitt lining to take up all slack due to wear, as fast as it is developed. The die is usually the upper member, while the punch is placed in the base. *K* is the die, screwed and dowelled to plunger *D*; accurately fitting the opening in this die is the shedder *H*, which is normally forced downward with its face flush with the face of the die by the action of spring *M*, which acts through the piston *N* and pins *O*. A similar construction is used in the bottom member. *J* is the punch, screwed and dowelled to the base. *L* is the stripper, surrounding the punch and accurately fitting it, and held firmly at the upper extremity of its movement by the pressure of the springs *Q*; it is restrained with its face flush with that of the punch by the heads on stripper screws *R*. Thus it will be seen that the faces of the punch with its stripper and the die with its shedder may be ground off smooth and flush with each other, presenting to the eye the appearance of two solid plates of metal, the division between the fixed and spring supported members not being visible if the fitting has been well done.

With this construction in mind, the details of the punch and die shown in Fig. 3 will be readily understood. Similar letters in each case refer to similar parts, but only the members of the device actually working on the metal are here shown. The outline of the punching which is to be made will be understood from the outline of the punch and its stripper, as shown in the plan view. There are two small holes, *c c*, and one larger hole, *b*, in the blank. For punching these small holes, in addition to the simple arrangement shown in Fig. 1, openings are necessary in the punch, and small piercing punches have to be placed within the aperture of the die, passing through holes in the shedder; the holes in the punch are continued through the base of the sub-press so that the waste material drops through beneath the machine. The piercing punches in the upper member are held to die pad *G* by holding screws *g* which draw these parts up into their tapered seats against the shoulders formed on them for the purpose. The fitting at all the cutting edges is done with great accuracy. The punch *J* fits die *K* very closely; the shedder *H* is fitted to the die very closely; the stripper *L* is fitted to the punch, and small punches *f* are accurately aligned and closely sized to their corresponding openings in the face of main punch *J*. Disappearing pins are shown at *h h*; they are used to guide the strip of stock, and are pressed down by the descent of die *K*, returning under the action of their springs as the ram ascends.

It will be understood of course that the sub-press is a complete unit, with punch and die and ram guiding surface always in place, so that no setting is necessary. The workman only needs to place the sub-press on the bed of the punch-press, insert the button on cap *E* in the holder provided for it in the face of the ram of the machine, and strap the base of the tool to the bed of the machine. He is then ready to commence work at once without any need for wasting time in matching up his dies, it only being necessary to adjust the length of the stroke to the proper amount. This is one of the advantages of the sub-press. Another of them will be immediately recognized upon considering the action of the parts on the strip metal from which the blank is punched. With the work in place, die *K* and with it small punches *f* descend, the latter passing through the stock until they almost meet the corresponding cutting edges in the lower member. As soon

as shedder H strikes the stock its motion is arrested, and it remains behind until the blank is separated, being meanwhile powerfully pressed upon the work by spring M. As the stock, while being sheared, is pressed down around the blank, it carries with it stripper L which also, by the influence of springs Q, exerts a heavy pressure on the stock. The whole area of metal being thus firmly held between plane surfaces, there is no danger of buckling or distortion of the stock as would otherwise be likely. As the ram moves upward again the blank is still firmly held on the stationary top of punch J by the shedder H. The stock, however, is carried upward

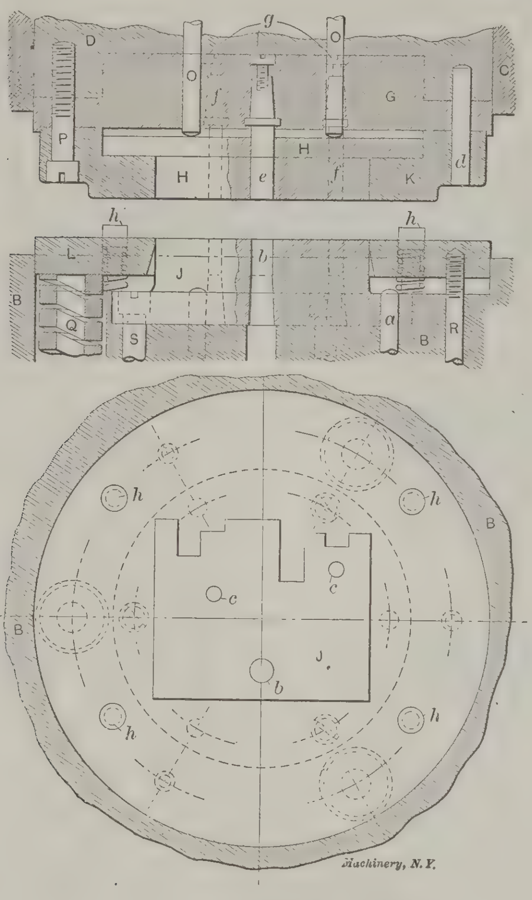


Fig. 3. Construction of Sub-press Punch and Die.

with die K by stripper L, forcing the stock back over the punching again until the movement of the stripper is arrested by the heads of screws R, at the time when the face of the stock is flush with the top of the punching. The work is thus pushed back into the stock in the same position that it occupied before it was severed from it and in many materials when the work has been nicely done, it is difficult at a careless glance to believe that anything has been done at all, both sides presenting a flush smooth surface where the parting occurred.

This condition is taken advantage of oftentimes in clock manufacturing. Gear blanks, for instance, are punched out from strips of metal and inserted back in their places again, minus, of course, the stock which has been punched out to form the arms and the hole for the "staff" or little shaft on which it is mounted. These strips, thus prepared, are then taken to machines where the staffs are inserted and fastened, it being much easier to handle the little wheels in this way than if they were severed and handled in bulk. A strip of stock thus treated is shown in the photograph reproduced in Fig. 1, the second one from the right at the bottom of the group; five of the pieces are shown in place in the stock while three have been pushed out. Besides the advantages of permanent setting of the punch and die and the holding of the stock to prevent distortion, which allows very narrow bridges of material to be left between wide openings, the suitability of the device for delicate work such as the piercing of small holes in thick stock will be appreciated by reference to Fig. 3. It will be noted that, no matter how small punches e and f may be, no portion of their projecting ends is at any time left unsupported laterally by shedder H or by the work. The shedder, pressing down firmly on the work, supports the end of the punch at the point where the pressure is applied. It is thus possible to use a very much more slender punch for a given thickness of stock than can be used in any other way. In Fig. 1, where a number of samples of sub-press work are shown, the topmost piece with the rack teeth in it, which is about 0.050 inch thick, has at its left hand end four 0.025 inch holes pierced through it. It will be seen that the thickness of the stock in this case is twice the diameter of the hole punched. Such a ratio has perhaps been undertaken with ordinary punches and dies, although the writer does not remember ever having seen the ratio of 1.5 to 1 exceeded; and in that case the hole in the die was considerably larger than the hole in the punch with the result that the pierced hole was very much tapered, the scrap coming out in the form of a conical plug. In the die under discussion, however, no allowance of this kind is made, the hole in the die being a very close fit to the punch, with the result that the hole pierced in the blank is as nearly a perfect one as could easily be obtained by any means short of reaming or grinding.

Another advantage of the sub-press, dependent in part on the accuracy of alignment provided, and the corresponding accuracy in fitting which can be given to the cutting edges, is that the work is remarkably free from fins and burrs. A consideration of the action of the press will show that there is practically no chance for burrs to form in a piece even where they would in an ordinary blanking die. It is of course necessary for the die to descend until the punch has all but entered it, if clean work is to be produced. There appears to be a slight difference in the practice of different operators in this respect, although this difference in practice would be expressed in the dimensions of only 0.002 or 0.003 inch, perhaps. Some of them adjust the stroke so that the die does not quite meet the punch. Others prefer to have them meet and even enter by an infinitesimal amount.

Attention has already been called to two of the samples of work shown in Fig. 1. The small parts there illustrated are within the ordinary range of the sub-press as used in this shop, but it is safe to say that there are many die-makers who consider themselves familiar with this tool who have yet to see dies built on this principle large enough to blank out such a piece as the largest one shown, which is quite 14 inches square. Nor is this the limit possible. The writer saw here dies of this type being made for heavy armature work, blanking out armature segments measuring possibly as high as 26 or 28 inches across extreme dimensions. The same advantages that obtain in the smaller presses, result from the use of the larger ones. There is a saving of time in setting up the tools; there is a possibility of punching small holes in

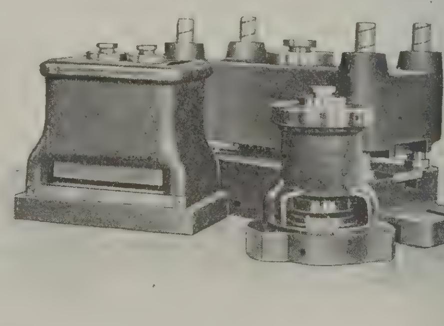


Fig. 4. Three Forms of Sub-presses.

thick stock or of leaving narrow bridges of metal between openings of considerable area; the dies, owing to their accurate and permanent alignment, may be fitted to each other much more closely, produce work that requires less finishing and comes more nearly to dimensions than can be done in any other way. At the same time, the construction effects a great increase in the life of the die, making it unnecessary to grind it anywhere nearly so often as would otherwise be the case. The only disadvantage that can be set off against these advantages is the increased cost, and it appears to be conceded that even with this consideration the balance is strongly in favor of the sub-press die.

Of course the larger sizes of these tools are not made in the familiar circular form illustrated in Fig. 2. Fig. 4 shows three different styles. The one at the rear has the sliding head guided by four vertical posts carefully ground and lapped to fit cast iron bushings. This is the construction used on heavy work. At the left is shown one in which the plunger is rectangular in shape. This works in a bearing lined with babbitt the same as the cylindrical form shown at the right of the cut and outlined in Fig. 2, although the bearing is not adjustable. The cylindrical form is used for the smaller sizes.

The making of a sub-press die requires all the skill of a and such holes as may be called for in the blank are transferred to die pad *G*. This is done by punches with outside diameters ground to fit the holes in the templet, and provided with sharp points concentric with the outside. The pad after being thus prick-punched, is put on the faceplate, the slight punch marks are carefully indicated, and holes are carefully bored to a taper to fit the punches which are to be inserted in them. The punches are finished by grinding on centers after they are hardened. They are supported at the shank by a male center, while the opposite end is temporarily ground to a point which revolves in a female center in the

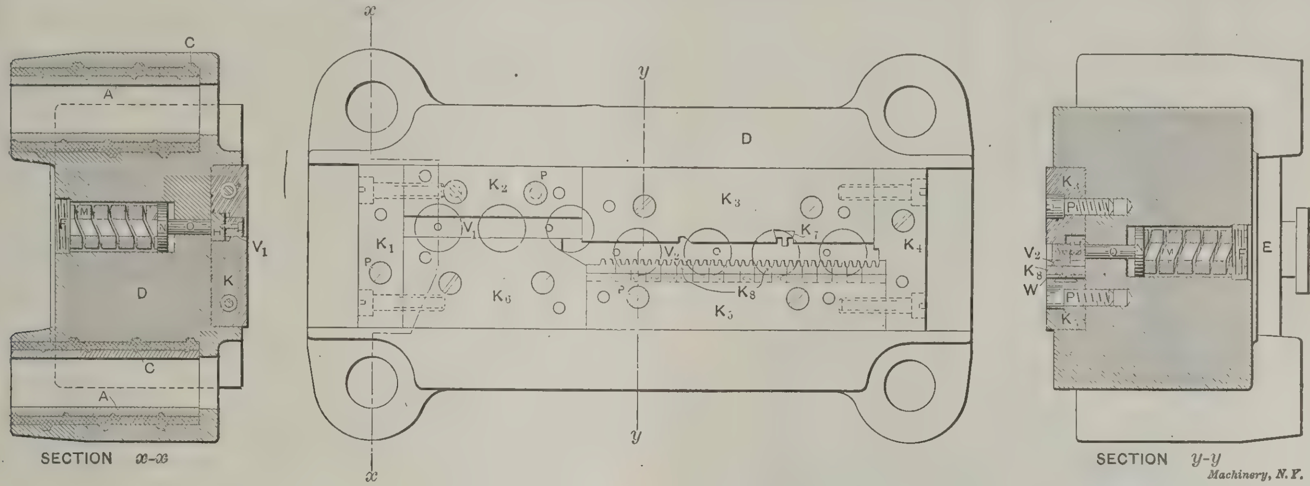


Fig. 5 Plan View and Section of Upper Member or Die of Sub-press shown in Fig. 7.

first class toolmaker. The method pursued by some, at least, of the men who are engaged in this work at the factory mentioned is about as follows: Taking the die shown in Fig. 3 as an example, the base *B* and cylinder *A* are machined and fitted together according to methods that would naturally be pursued by any good mechanic. The inner surface of the cylinder is grooved so that babbitt may be securely locked in place. Plunger *D* is then machined, and the outer surface ground and fluted with semi-circular grooves. Especial pains are taken to have these grooves parallel with the axis of the plunger in both planes; if this is not done the die may be given a slight twisting movement instead of the perfectly straight forward one that is required, since upon these grooves other end of the grinder. The punch may thus be ground all over with the assurance that the pointed end is true with the exterior—a necessary provision as will appear later.

It might be noted here that no draft is given to any of the cutting edges of these tools, since they do not enter each other, at least not to any appreciable extent, and since the stock in entering and leaving the cutting edges is positively moved, no clearance is necessary and the die cuts practically the same kind of a blank at the end of its life that it did at its birth. Shedder *H* is fitted to die *K* and the holes for the punches are transferred to it in the same way as for the die pad, by means of carefully machined prick punches which fit the holes in the models, these prick punch marks being afterward indicated

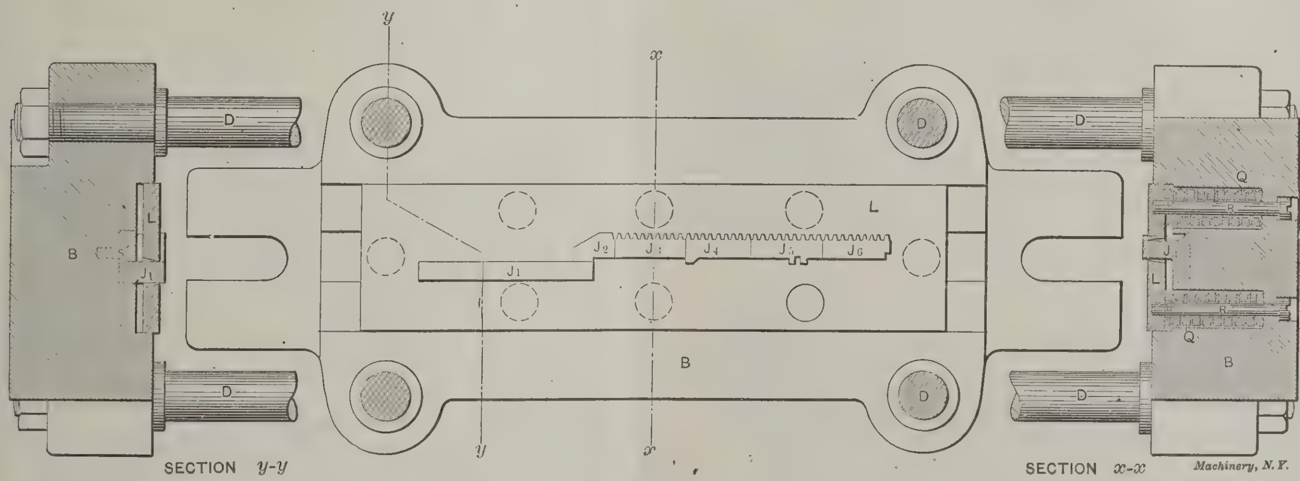


Fig. 6. Plan View and Section of Lower Member or Punch of Sub-press shown in Fig. 7.

depends the angular location of the punch and die with relation to each other. The plunger is now inserted within the cylinder and, with proper precaution, the space between them is filled with babbitt which flows into the grooves in the cylinder and those in the plunger as well, locking with one and guiding the other. After being cooled, the plunger is pumped up and down to insure a perfect bearing and the nut *U* is screwed down until all slack is taken up. Die *K* is now made to accurately fit the templet or model furnished the toolmaker as a sample. After it has been completed, it is hardened and fastened in place. Then the model is inserted within it, to run true on the faceplate. The punch is now worked out a very slight amount larger in all its outlines than the die. The model is laid upon it, the holes transferred to it as in the case of the other parts, these holes being then indicated and bored out, but not ground in this case, being left three or four thousandths smaller in diameter than finished size. The punch is fastened in place in the base, lining up as nearly as possible with the die. The ram is forced downward in a screw press until the punch enters the die very slightly, cutting a thin chip from its sides to bring them to the shape required. The punch is then worked down to this point all

around and again entered in the die a short distance further, the operation being repeated until the two parts fit perfectly.

In finishing the holes in the punch, after the hardening process plugs are driven in each of them as shown in Fig. 8. The punches f still with their ends pointed concentric with their outside surfaces, are fastened in position in the upper member, and the ram is brought down until these punches mark slight centers in the top of the brass plugs, when the ram is again raised and the punch J removed. The punch is then strapped to the faceplate and each of the small plugs is

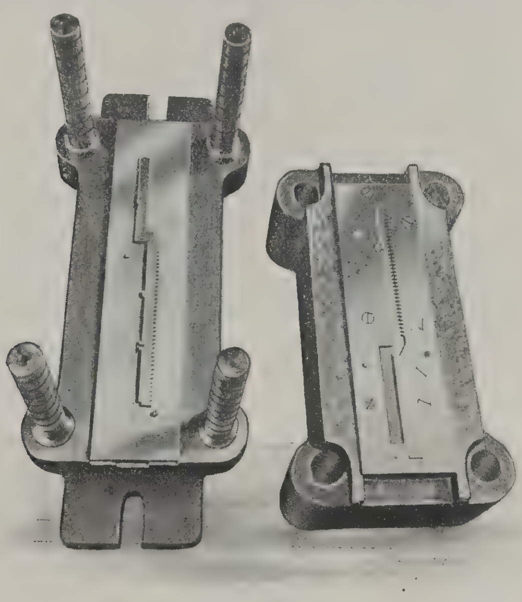


Fig. 7. A Good Example of Sub-press Construction.

in turn indicated from the prick punch marks, when it is removed and the hole is ground to size with a steel lap charged with diamond dust in an internal grinding fixture. The stripper is fitted to the punch in the usual manner. With the parts thus made and fitted great accuracy is obtainable.

A die of the four-posted type is detailed in Figs. 5 and 6, Fig. 6 showing the lower member or punch while Fig. 5 shows the upper member or die. This sub-press is used in making the piece with rack teeth shown in the upper right-hand corner of Fig. 1. A slightly different method of procedure is followed in this case than with the sub-press just described. The punch and die are finished before the upper and lower members are lined up with each other. When the time comes for doing this the punch is entered in the die, the two parts being parallel with each other as to their faces, when bushings A are slipped over the posts until they rest in the bottom of the cast counterbores in die holder D, Fig. 5. This counterbored space has had packets gouged out in the sides for

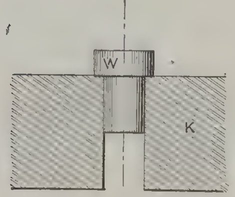


Fig. 8. Plug for Centering Holes for Grinding.

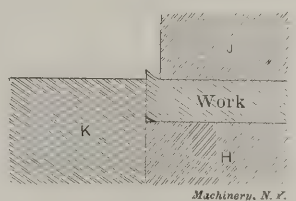


Fig. 9. Action of Badly-fitting Punch and Die.

the babbitt to flow into and lock with. The grooves shown in the posts in Fig. 4, are not yet cut in Fig. 6, they being still smooth and true as the grinding left them. The space C being poured full of babbitt and allowed to cool, the punch and die are permanently aligned with each other without possibility of shifting. The posts are then removed and the spiral grooves for oil distribution are cut in them.

One of the noticeable points about this die, as shown in Fig. 6, although the work is so closely fitted in the tool itself that the eye is scarcely able to distinguish the construction, is the fact that the section of the cutting edge which shears out the rack teeth is built up of small segments, each containing two teeth only, these segments being dovetailed into the larger piece, K_5. Each of these small pieces, K_8, is secured by two dowels which pass through from side to side of K_5, locking the parts firmly together. This costly and difficult construction was necessitated by the demand for accuracy in the spacing of the teeth. With the sectional construction shown the parts are not affected sensibly in the hardening. That piece K_5 may not be warped out of shape; it is ground to size in all its surfaces, top, bottom, sides and even in the dove-tail, so that when completed its plane surfaces are straight and parallel. The dove-tails of the die sections K_8 are next machined to fit this and inserted, being then spaced the proper distance apart. The holes in K_5 are then continued through pieces K_8, which are taken out and hardened, and returned to be dowelled in place. It will be seen that this die is constructed on the sectional plan throughout. This makes it possible to finish on the surface grinder most of the cutting edges. Troubles due to distortion in hardening are thus entirely avoided. The proper end measurements between vital points in the model are also preserved by leaving a slight amount of stock where two sections of the die come together, the parts being ground away at this point until the proper dimensions are obtained.

In the few cases where the grinding wheel will not finish the cutting surface, great use is made of diamond laps, these being in the form of steel sections of proper contour to fit the part of the die they are working in, these steel pieces being charged with diamond dust and reciprocated vertically

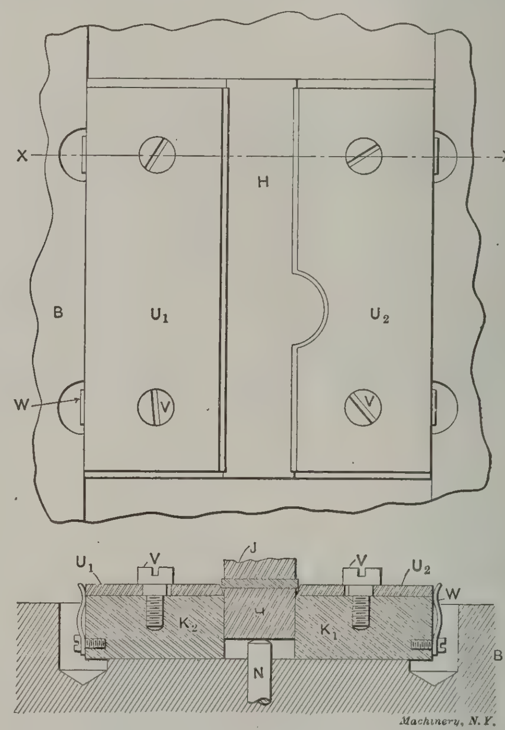


Fig. 10. Shaving Die with "Nest" for Locating the Work.

in filing machines, of which a large number are used in this shop. The little dove-tail in which part K_7 is inserted, for instance, was finished in this way. The back of the dove-tail is perpendicular but the two sides slope somewhat from the vertical forming a wedge-shaped opening enlarged toward the rear. Section K_7 is then driven in from the rear, finished off, and ground with its front face flush with the rest of the die. In Fig. 7, which shows this sub-press, this little section has not yet been finished off, so that it is seen to project above the remaining part of the die.

This is the first operation or the blanking punch and die. The pieces produced are afterward subjected to the action of a shaving die, the original blanks being left with 0.002 or 0.003 stock for this purpose which is trimmed off in the final operation. The punch for this first or blanking die has the rack section subdivided into four parts only, which are matched up carefully with the sectional die just described. In the shaving die, however, this punch is built in sectional form as described above for the blanking die, so that great refinement in measurements is secured.

The sub-press just described is that shown at the back of Fig. 4 and opened up in Fig. 7. Its action is exactly identical with the smaller one just described; it has all its advantages and presents the same deceptive appearance of perfectly homogeneous surfaces in the punch and die when it is completed. In the illustration the shedder and stripper springs have been slacked up in order to show the outlines of the cutting edges, but this is not the normal condition.

A feature of the shaving die system, to which reference has been made, is the use of a "nest" to locate the work. In this trimming operation the punch is in the upper member and the die in the lower one. On the surface of the die, of which an example is shown in Fig. 10, are placed steel guiding plates, U_1 and U_2, which form the nest referred to. They have their edges shaped to the outline of the piece to be operated upon and they are pressed inward by flat springs *W* at the outer edge, being allowed a slight lateral movement although retained from sidewise displacement by shoulder screws *V*. The holes through which these screws pass are slotted to permit this; the end of the slot limits the inward movement of the plate. As shown in the enlarged views, Figs.

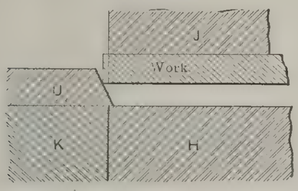


Fig. 11. "Nest" with Work in Place.

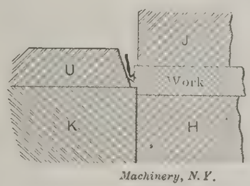


Fig. 12. Work being Trimmed in Shaving Die.

11 and 12, the inner edges of these plates are bevelled backward so as to form a recess in which the work may be located. The descent of the punch forces the plates out, which, as they are displaced, still guide the work so that it is properly centered over the die. These beveled edges of the plates have the further advantage of curling the chip out of the way where it does not clog the tool and may be easily cleaned off. The shedder coming up from below and removing the work, closes the lower opening effectively so that the whole device is chip tight.

Even greater accuracy is advisable in the fitting of the punch and die in this shaving sub-press than is necessary in that used for blanking only, if it is desired to produce clean work free from burrs. The necessity for this will be appreciated upon examining Fig. 9, which shows in magnified form the action of the cutting edges. If the punch *J* does not match up closely with the edge of die *K*, the stock is bent upward leaving a sharp burr, while the punch impresses the outline of its cutting edge on the top surface of the blank.

Mr. Haney, the general manager of the Sloan & Chace Mfg. Co., has ambitions for this branch of the firm's product which are by no means modest. It is his aim to build the greater part of the dies made in this country for purely manufacturing purposes. The idea of having the tool work of a manufacturing firm done by an outside party has a number of commendable features about it. Suppose a new concern is about to enter in business as a manufacturer of typewriters. There has to be an enormous initial expense for tools and, as a part of it, the buying of a great many costly machines, the establishment of a large toolmaking department, together with the hiring and organization of an efficient toolmaking force—an exceedingly difficult undertaking. In general it entails an amount of worry and expense which can only be appreciated by those who have been unfortunate enough to have actually met these conditions. Where it is not necessary to have a larger toolroom equipment and organization than is required for keeping tools in repair and for making occasional additions to the line as slight changes are made, a large part of the time, expense, and worry might be avoided. This is where the independent toolmaking firm has its strong hold. Filling orders for a great number of different concerns, they can have a nearly constant volume of business, a constantly used equipment of fine machinery, and an efficient corps of diemakers, working under the assurance that their jobs are permanent ones; this would not be the case were they working for a new firm just starting in business, who then require many more men in making these tools than they will to keep them in repair and make occasional changes.

It is evident that manufacturers have begun to look at the matter in this light, for the firm of which we are speaking has more of this work on hand at the present time than it can attend to, some of their contracts being of a size that is startling both as to the number of tools and their money value. The only factor which hinders a rapid growth of this business to many times its present size is the fact that it has so far been exceedingly difficult to get men who are capable of doing the work that is required of them. Almost all of the workmen have learned the business in this shop, some of them having been there for many years. Of the many who have come in response to advertisements and in the ordinary course of their wanderings, only a few have been found who are able to meet the demands made upon them. The firm is preparing in the near future to institute an apprenticeship system with the hope of educating bright boys to be capable and efficient diemakers.

* * *

STRAIGHTENING RACKS MADE FROM COLD ROLLED STEEL.

The phenomenon of skin tension in cold rolled steel is one with which all shop men are familiar. This process of working the steel develops permanent stresses in the outer portion of the metal, and if this outer portion is taken off on one side of a square bar, for instance, the stresses in the opposite and untouched side will be sufficient to draw the stock into an arc of a circle. This condition is met with in cutting racks in square cold-rolled stock, a practice in common use at the present time, since it avoids the necessity for planing the four sides of the work as would have to be done if machinery steel were used. After the teeth are cut in these racks, they are so distorted that drastic treatment has to be applied to bring them back to a condition in which they are fit for use.

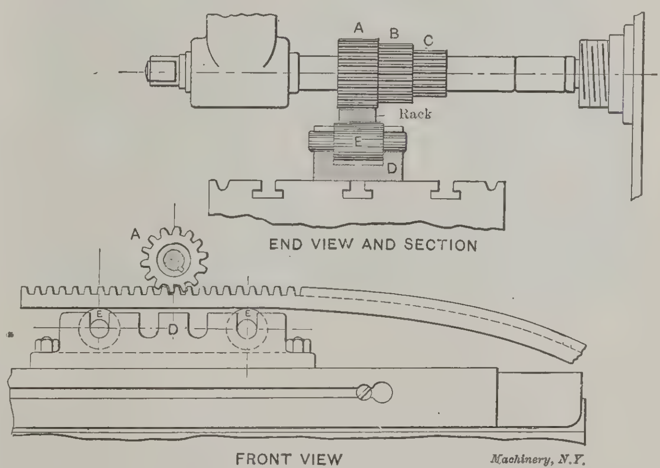


Fig. 1. Straightening Cold-rolled Racks in the Milling Machine.

Fig. 1 shows the principle of a device for this purpose which has been used for some time by the R. K. Le Blond Machine Tool Co., Cincinnati, Ohio.

A plain miller, which stands near the rack cutter, is made use of. An arbor is mounted in the spindle, carrying, ordinarily, three gears, *A*, *B*, *C*, of the pitches most commonly used. On the table is clamped a channel casting *D*, which is provided with four slots in each side, in which may be placed the rollers *E*, which are made of about the dimensions shown. The use of the device will be readily apparent. The rolls are dropped into place at such a distance apart as best suits the work in hand, and are brought in line with the proper gear on the arbor, which is then located centrally between the two rollers. The rack is now fed in between the rollers and the gear, and the table is brought up until pressure enough is exerted on the rack to straighten it. The spindle is revolved slowly and the rack feeds through and is bent back into shape again by the pressure between the rolls and the pinion. The gears *A*, *B* and *C* are so proportioned that they bear on the tops of their teeth as well as on their sides. This prevents stretching the racks when in mesh with the gears. Were this

not so, the wedging action of the gear teeth, under heavy pressure, would spread the rack teeth and increase the pitch, lengthening the rack to some degree at least.

While this arrangement worked well on small racks, when it came to the heavier ones the straightening imposed a strain of several tons on the spindle, and it took about 3 horsepower to drive the work through the rolls. This was too severe service to give the miller, and a special machine was therefore designed, working on the same principle but better adapted for its intended use. The machine consists essentially of a bed *A* (mounted on suitable legs of ordinary pattern) to which is cast the bracket *B* carrying the main spindle *C* of the machine; the bracket in its design resembles the column of a Stiles pattern punch press. At *D* is a block adjustable for the desired height through hand wheel *E* and the attached gear train *F G* and elevating screws *H*. These elevating screws run in nuts seated in counterbores in the bed of the machine. Pulleys *J J*, driven in opposite directions by open and crossed belts at suitable speed for the work being done, run loosely on shaft *K*; either of them, however, may be clutched to the shaft by moving handle *L* to the right or left, as may be desired. This handle operates an internal clutch similar in construction to the well-known device used on the double back gears of the Le Blond milling machine. To shaft *K* is keyed a worm, which in turn drives worm wheel *O* and through it spindle *C*. On the end of the spindle may be mounted any one of the gears *P*, which are made in pitches ranging from 5 to 14 to agree with the rack which is to be straightened. Rollers *Q*, which furnish a support for the rack, revolve in seats in block *D* in a manner exactly similar to the device illustrated in Fig. 1. As in the previous case four different slots are provided so that the distance between the rolls may be varied to suit the stiffness of the rack being straightened. The operator stands at the right of the machine in Fig. 2 with his hand on the controlling lever *L* and runs the rack back and forth, bringing up the rolls meanwhile with the handwheel *E* until the rack has been straightened. The handwheel is graduated in thousandths of an inch to allow the wheel to be brought to the same point each time when running through a lot of similar racks. The details of this device, which are very well worked out, can easily be gathered from a study of the drawings, which are shown in Fig. 2 complete in every respect save that the dimensions are omitted.

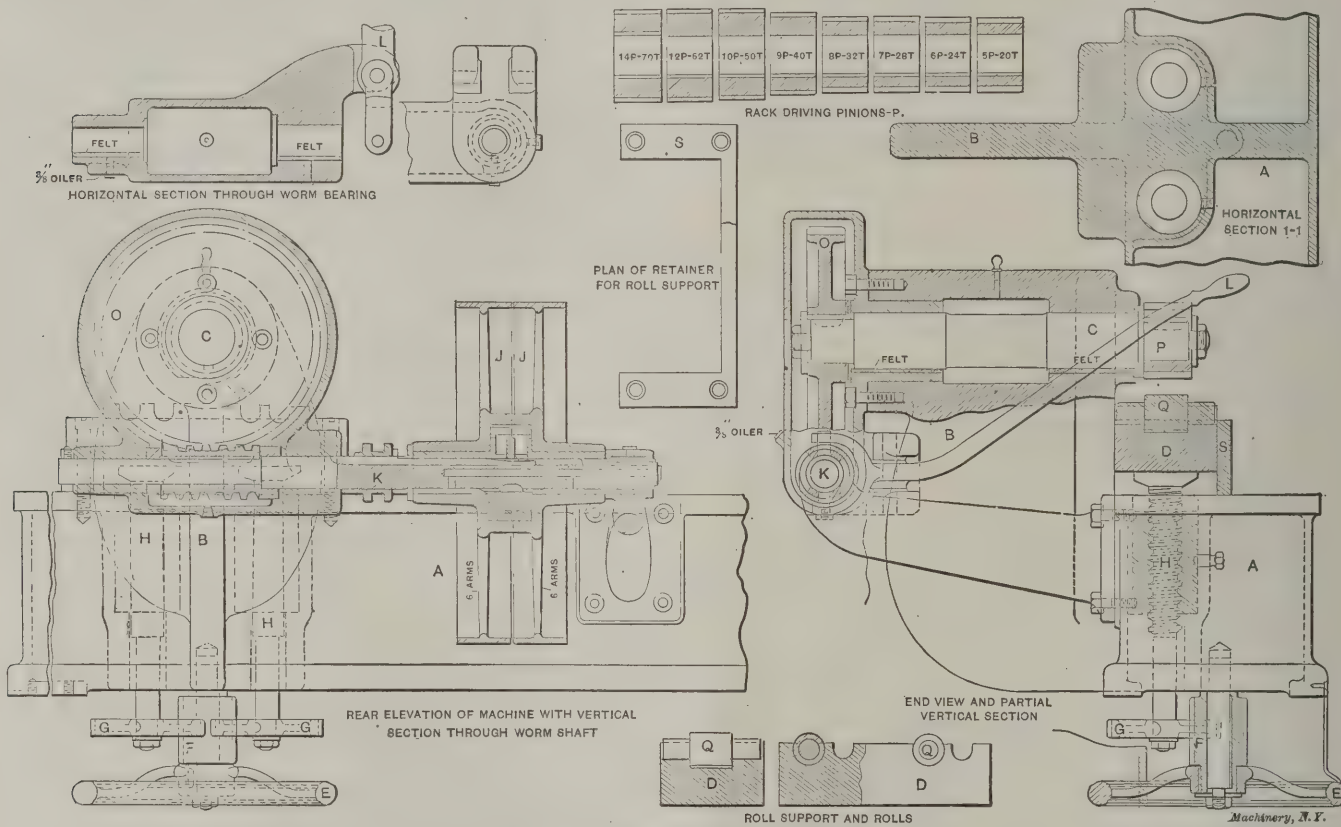


Fig. 2. Machine for Straightening Cold-rolled Steel Racks.

ENDURANCE RECORD OF TAPS.

In a comment on the endurance record for taps which appeared in the November issue, Samuel Hall's Sons, New York, say that they have an average of a ¾-inch tap tapping 10,400 nuts ¾-inch thick; and a 1-inch tap tapping 9,300 nuts 1-inch thick.

William H. Haskell Mfg. Co., Pawtucket, R. I., say: "We do not think that the number of holes tapped as mentioned by your correspondent is exceptional, as we should consider, that unless a tap of the size mentioned tapped a considerably larger number of holes than is mentioned by you, that the tap was faulty. We know that our taps tap more than 10,000 holes, but how many more, we cannot tell."

The Boston Bolt Co., Boston, Mass., say they would not consider that these taps did any specially large amount of work inasmuch as 10,000 holes in cast iron is not much work for a tap to do. Their explanation is that under favorable conditions a tap should tap at least 25,000 nuts of wrought iron, and they imply that the same tap should be good for a greater number of holes in cast iron than in wrought iron. "The number of holes we could tap probably depends upon the quality of the stock, on the temper of the tap, and also how much stock the tap has to remove. We should not be surprised if under some conditions a 1-inch tap would tap 40,000 nuts. We have no exact data to which we can refer but certainly if a tap did not tap 10,000 pieces we would consider it inferior."

The Garland Nut & Rivet Co., Pittsburg, Pa., say that in tapping iron and steel nuts they could not approach the record made by Mr. Sallow's taps.

The Graham Nut Co., Pittsburg, Pa., say the tapping of nuts is largely regulated by the speed of the tap and consequently the tap sometimes suffers on that account. They consider about 5,000 inches a good average for nut taps. This would be equal to about two-thirds the record made by Mr. Sallow's taps.

* * *

The excellence of the design of the sister ships *Lusitania* and *Mauretania* of the Cunard Steamship Co. is made publicly evident from the fact that the company has been awarded a grand prize for these models at the Milan Exposition. The prize awarded extended also to other models of the company's well-known steamers.

ADJUSTABLE FORMER FOR BEVEL GEAR PLANING.

G. L. H.

It is a well-known fact that in order to correctly plane the teeth of a bevel gear the cutting point of the tool should work toward the apex of the pitch cone. Bevel gear planers are built on this principle, the tool rest slide being hinged at one end in the apex of the pitch cone of the gear being cut (or at least arranged so that the tool will travel toward that point), the other end being supported on a former which determines the shape of the tooth. This principle is illustrated in Fig. 1. A convenient method of cutting ordinary bevel gears by the use of a comparatively small number of formers is described in the following paragraphs.

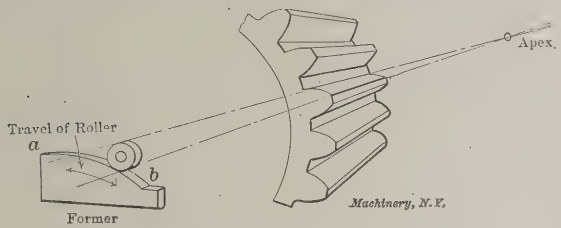


Fig. 1. The Principle of the Bevel Gear Planer.

Bearing in mind the fact that to a given circle there corresponds one and only one shape of involute, one can readily see by referring to Fig. 2 that a pair of formers, one for the upper and one for the lower side of the tooth, would serve for all gears if they could be set at any desired distance, H, from the apex of the pitch cone. If the shape of the former is the same as that of a gear tooth whose pitch radius is R, it will be suitable for cutting the bevel gear indicated by a full section, as the curvature of the gear tooth will be reduced from the curvature of the former in the same proportion as R is to r; but a bevel gear of any other pitch cone angle and number of teeth, for instance the one shown in part only, having a pitch cone angle A_1, can be cut with the same former, if only this former be set in the new pitch cone at such a distance, H_1, from the apex that the new pitch radius, R, is the same that it was before. The number of teeth in either of the gears is immaterial so long as the templet is long enough. A long tooth will use the whole of the templet from a to b, as shown in Fig. 1, while a shorter tooth, such as that represented as

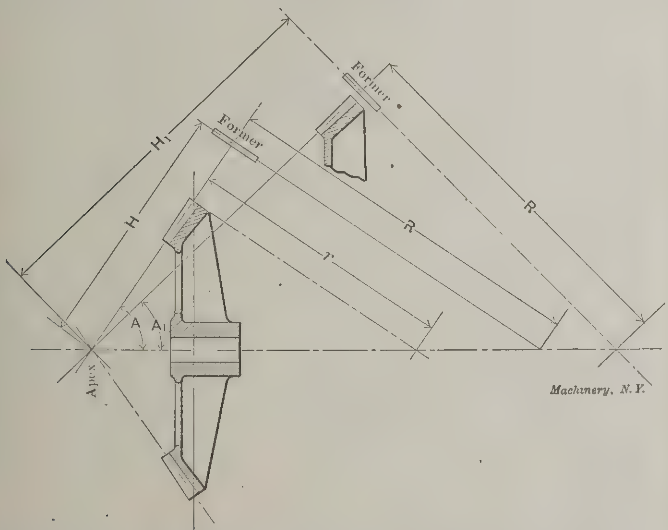


Fig. 2. Planing Gears of Different Angles with the same Former.

being cut, will only use as much of the former as is indicated.

As stated, it would be possible for one former to cover the whole range of pitch cone angles A, but since on any given machine, distance H has but a limited variation, this necessitates a series of formers in order to include all the gears capable of being cut on the machine. Suppose we have a machine on which a former can be set between 30 and 45 inches from the apex. Let H and H_1 in Fig. 2 represent these two extremes of distance, respectively. It is apparent from this diagram that $\frac{R}{H} = \tan A$. If 2 inches is the smallest value for R to be used on this machine we can, by using it in the above formula with different values of H between 30 and 45, obtain the corresponding values of A which, when laid out on the diagram, Fig. 4, will be represented by the curve $c\,d$. This diagram has, however, been extended, giving a minimum value to H of 20 inches and a maximum value of 55 inches. In a similar way all the other curves are found, the values of R for each succeeding one being chosen so that each curve intersects the 45-inch line at about the same value for the pitch angle that the preceding curve intersects the 30-inch line, thus always covering the field between 30 inches and 45 inches, the assumed limits of the machine.

Take, for example, a bevel gear with a pitch angle of 30 degrees; according to the diagram the 21-inch former, or a former made for a radius, $R = 21$ inches, is the one to be used, and the reading of the diagram shows that it should be set about 36¼ inches from the apex. If the machine allows a shorter or longer adjustment of the former than that assumed above, the 31½-inch former at about 54 inches or the 14-inch former at 24¼ inches from the apex would give the same tooth form. When the pitch radius of the former exceeds 200 inches the involute for any ordinary pitch of tooth is practically a straight line, and a former laid out accordingly may be set at any distance from the apex.

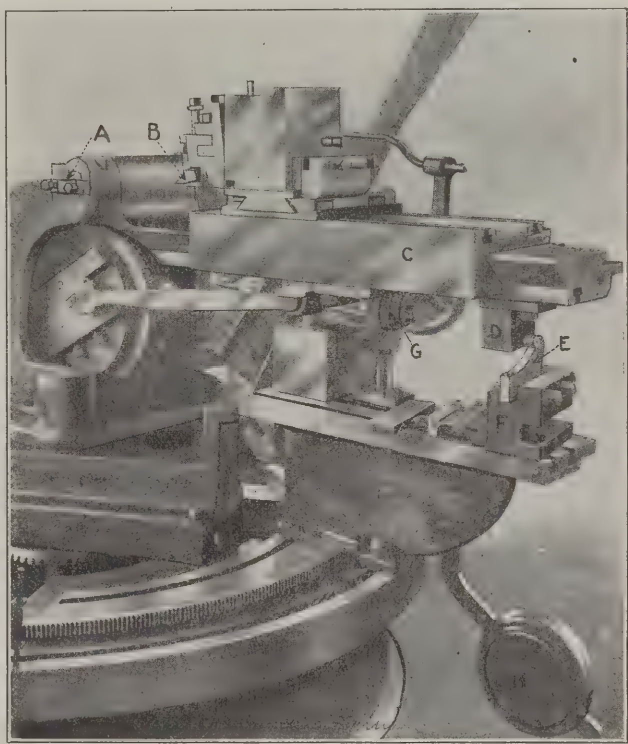


Fig. 3. Gear Planer Arranged with Adjustable Former.

In the above remarks involute formers only have been considered. Owing to the fact that the cycloidal curves vary not only with the pitch radius, but with the pitch as well, and consequently with the number of teeth in the gear, a simple diagram as shown above cannot be obtained for cycloidal formers.

Fig. 3 shows a tool slide and its controlling mechanism on a Gleason gear planer. At A is the apex of the pitch cone of the gear, the point toward which the tool B always travels. C is the reciprocating slide on which the tool is mounted. At D is the block carrying the former roller which follows the outline of former E; F is the support for the former. Both F and D are readily adjustable between the limits, in this machine, of 30 and 45 inches, as explained above. Counterbalance H supports a post and short track on which runs roller G attached to the support for the cutter slide. This serves to take a large part of the weight of the mechanism off of the former, thus making the guided parts more sensitive and easily handled.

[The scheme described above by our contributor allows the use of a smaller number of formers than would otherwise be necessary and practically makes allowance for the errors that

would be introduced in cutting, in the usual way, a gear whose pitch angle was about half-way between those of the two nearest formers. So far as we know, however, the make of planer to which this idea may be applied is not built at the present time in such a way that the distance from the former to the apex is adjustable. The machine shown in Fig. 3, on which the idea worked very nicely, is evidently of an old design. In the later machines, as we understand the matter, dimension H in Fig. 2 is constant for any given machine, and the formers are made to fit this dimension, being cut in a generating machine by a milling cutter, on a spindle which is pivoted to swing about the apex of the pitch cone in the same way that the tool slide does.—EDITOR.]

* * *

Aluminum may within the near future enter into serious competition with copper for the transmission of electricity for lighting, traction and power purposes. While the electrical conductivity of aluminum is only 63 per cent of that of copper, the specific gravity of the metal is less than one-third of that of copper, and thus conducting wires of aluminum, although of larger sectional area than those of copper with equal conductivity, will still be less than one-half the weight of the latter. It follows, therefore, that even if the price of aluminum were double that of copper, which it is not, a bare conductor made of aluminum would still be somewhat cheaper than the copper conductor. With insulated conductors there will be some difference owing to the additional insulation material made necessary by the larger area to be covered. —*Practical Engineer.*

THE WORLD'S SUPPLY OF IRON ORE.

Some time ago a prominent Scandinavian metallurgist predicted a famine in iron ore in about 100 years' time. In the United States this famine was to occur within thirty or forty years at the present rate of consumption. This, however, was not founded on a basis of the consideration of all the facts in the case. There is in existence a great amount of iron ores at the present time not considered worth using, because of their impurities. In the future, however, if the supply of the purer iron ore now used should prove to become less abundant, it is safe to predict that these ores will be largely used to make up the world's supply. This is true no less of America than of Europe. A number of mines were closed thirty or forty years ago in England because cheaper and better iron ore cut them out of the market, but when this supply of cheaper and better ore will be exhausted, the old mines will most certainly be reopened. An English metallurgist claims that three counties in England would supply that country at the present rate of consumption with ore for 200 years, and that considering all the iron ore possible to be used, Great Britain would have enough to last for 1,000 years without importation, provided that the consumption would not rise above the present rate. Probably similar statements would be true of the United States, and it is in all likelihood too early to commence to contemplate what to do when the world's supply of iron is exhausted. Methods are constantly being perfected for cheaper ore reduction, and while the quality of ore which will be used in the future may be poorer, the price of iron itself need not necessarily rise to any great extent.

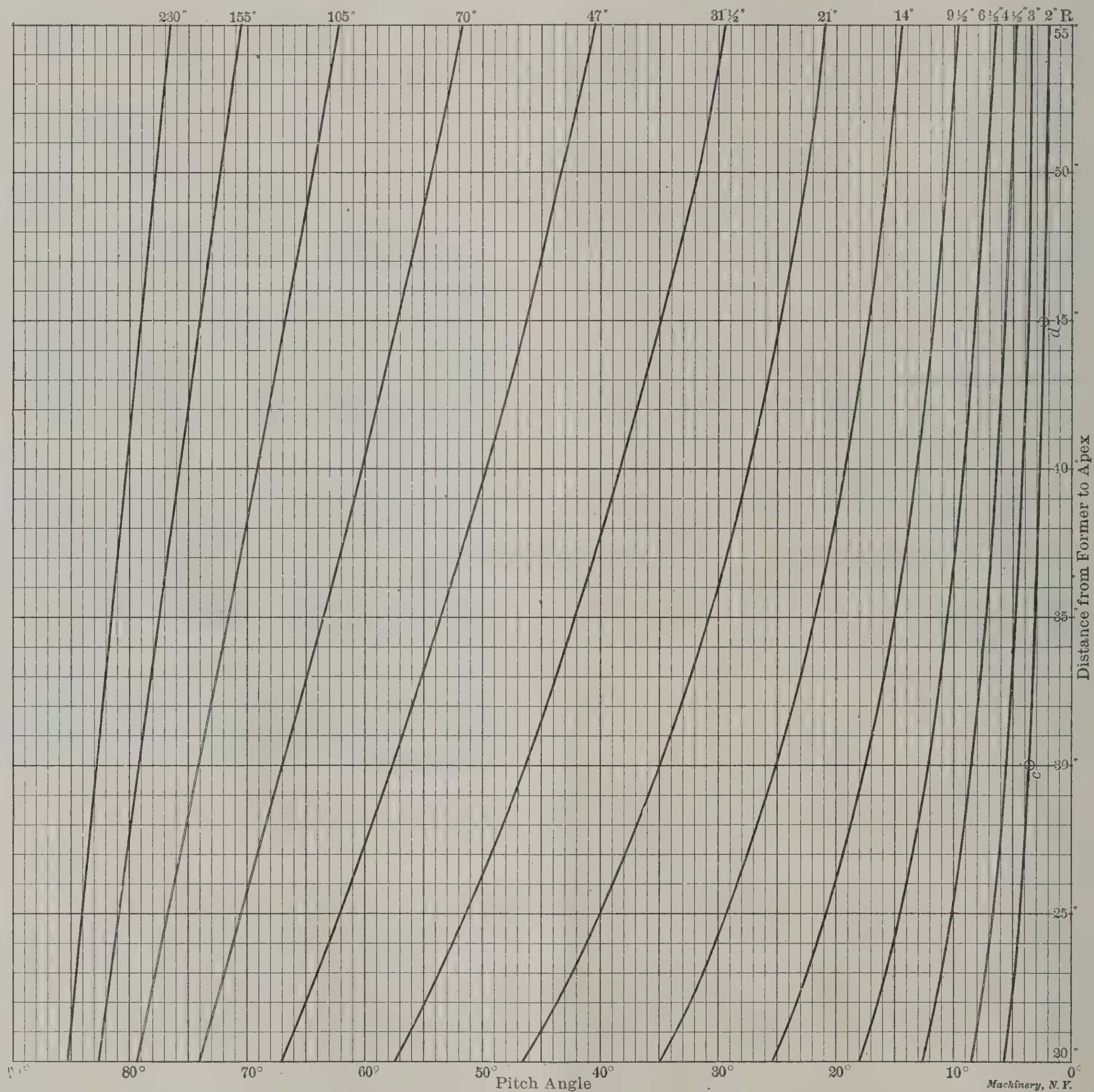


Fig. 4. Diagram for Selecting Formers.

DRILL JIGS.—2.

E. R. MARKHAM.

Holding Devices.—It is necessary to hold the work solidly in the jig without any chance of its changing location. Should the location change after one or more holes are drilled, and before all are drilled, it would cause a variation that would in all probability spoil the piece of work. When but a few pieces are to be drilled with a jig it is not generally considered advisable to make jigs with fastening devices, the work being held in place with a clamp, as shown in Fig. 7. In order to do away with any possibility of change of loca-

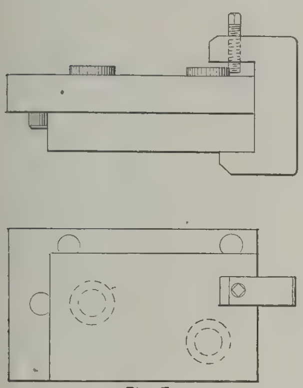


Fig. 7

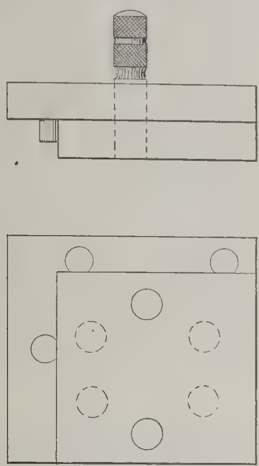


Fig. 8 *Machinery, N.Y.*

Means for Holding Work in Drill Jigs.

tion, a pin is forced through the jig hole and the hole in the work after drilling the first hole. If many holes are to be drilled in a piece it is advisable to have two pins. After drilling a hole in one end of the piece, force in a pin, then drill a hole in the opposite end, and place a pin in this hole, as shown in Fig. 8. The pins in opposite ends of the piece will prevent its slipping when the rest of the holes are drilled. Many different forms of fastening devices are provided, the design depending on the class of work. One of the most positive methods consists of a screw which passes through a stud or some elevation on the jig, and presses against the work, forcing it against the locating points, or stops, as they are called. The screw may have a knurled head, as shown

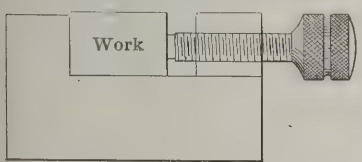


Fig. 9

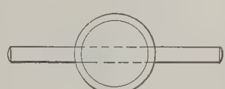


Fig. 11

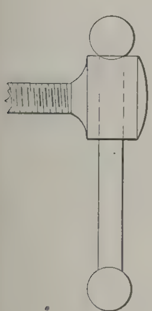


Fig. 12

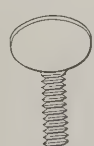
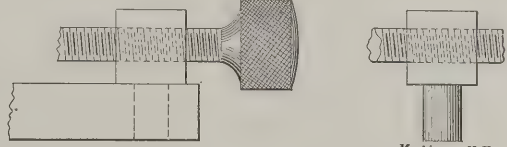


Fig. 10
Machinery, N.Y.

Means for Clamping Work in Drill Jigs.

in Fig. 9, or a thumbscrew may be used, Fig. 10. Sometimes it is necessary to exert greater pressure than can be applied by means of a screw of the ordinary form. Then, it is possible to make a screw with a round head, drill a hole through it, and through this hole pass a piece of wire as shown in Fig. 11. By this screw sufficient pressure can be applied. When it is necessary to exert a greater amount of power than would be possible by the use of a pin of the length shown in Fig. 11, one may be used that will slide freely in a hole in the head of the screw. A ball placed on each end prevents its falling out. By getting the full length of the pin on one side of the screwhead as shown in Fig. 12, a much greater amount of power is obtained. At times the stud which supports the screw may interfere with the placing of the work in, or the removal of the work from the jig, or it might be necessary to turn the screw for a considerable distance each time the work was placed in or taken out of the jig. In such cases a stud could be provided that could be removed from the jig when the screw was relieved of its tension against the piece of work. Such a stud is shown in Fig. 13.

The more common method of fastening work is by means of a cam of suitable form. Cams of the ordinary design are not as powerful as the screw, but they have the advantage of being more quickly operated, and in the case of light work where but little strength is required, they answer the pur-



Machinery, N.Y.

Fig. 13. Clamp Screw Mounted in Removable Stud.

pose much better. The designer should bear in mind that a few seconds' time saved on each piece of work amounts to a large saving in a day when a number of hundred pieces are placed in and taken out of a jig. And in these days of competition every means of saving time consistent with quality of work should be considered. When the work bears against two points—one on the side and one on the end—the cam should be designed so that its travel against the work will force it against both, rather than away from one. Fig. 14 shows a piece of work held by a cam which, by means of the handle, forces the work inward and in the direction of the arrow, thus holding it against the locating pins *a a* and the end stop *b*. In order to get as much pressure as possible with a cam, it is necessary to have the portion that bears against the work when it is against the locating surfaces nearly concentric with the screw hole. This being the case, it is obvious that the pieces must be very nearly of one size, while in the case of a screw binder any amount of variation may be taken care of. Thus it will be seen that a screw may be used where a cam would not answer. However, it is advisable to use a cam in preference to a screw when possible, but at times the piece of work may be subjected to repeated jars which would tend to turn a cam, thus loosening the work. In such cases a screw is preferable. If a cam would be in the way when putting in or taking out work, it may be made removable as

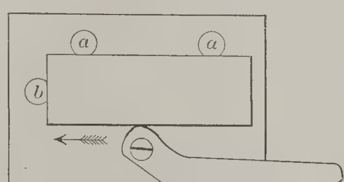


Fig. 14

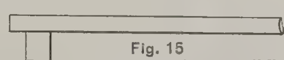


Fig. 15
Machinery, N.Y.

Cam Clamp for Drill Jigs.

shown in Fig. 15. At times a tapered piece of steel in the form of a wedge may be used to hold work, as shown in Fig. 16.

When many pieces are to be drilled in a jig made in the simple form shown in Fig. 17, the drill wears the walls of the holes, enlarging them sufficiently to render accuracy out of the question. Where jigs are to be used enough to cause this condition, the stock around the walls of the hole may be hardened, if the jig is made from a steel that will harden. If made from machinery steel, the stock may be casehardened sufficiently to drill a large number of pieces without the walls wearing appreciably. This, however, would not answer when accuracy is essential, as the process of hardening would have a tendency to change the location of the holes.

When the jig is to be used for permanent equipment, or

where many holes are to be drilled, it is customary to provide bushings—guides—made of tool steel and hardened. These are ground to size after hardening, and being concentric, may be replaced, when worn, by new ones of the proper size. It is the common practice to make bushings for drill jigs on the same general lines as shown in Fig. 18, the upper end being rounded to allow the drill to enter the hole readily.

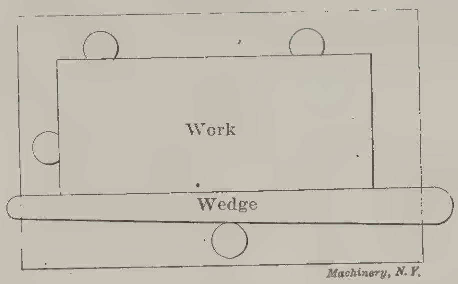


Fig. 16. Wedge Acting as Clamp in Drill Jig.

A head is provided, resting on the surface of the jig; the portion that enters the hole in the jig is straight, and is ground to a size that insures its remaining securely in place when in use.

If the hole is sufficiently large to admit a grinding wheel, it is ground to size after hardening. In such cases it is, of course, necessary, to leave the hole a trifle small—0.004 inch—until it is ground. If the hole is not large enough to allow of grinding, or if there is no means at hand for internal grinding, the hole may be lapped to size by means of a copper lap, using emery or other abrasive material, mixed with oil. When the hole is to be lapped rather than ground, leave a smaller amount of stock to be removed by the operation, say 0.001 inch or 0.0015 inch. After grinding or lapping the hole to size, place the bushing on a mandrel and grind the outside until it is a pressing fit in the hole. While on the mandrel be sure to grind the under portion of the head, *a*, Fig. 18, to insure its being true with the body. Before starting to grind the outside of the bushing, test the mandrel for truth. This should be done *after* placing the bushing on it rather than before.

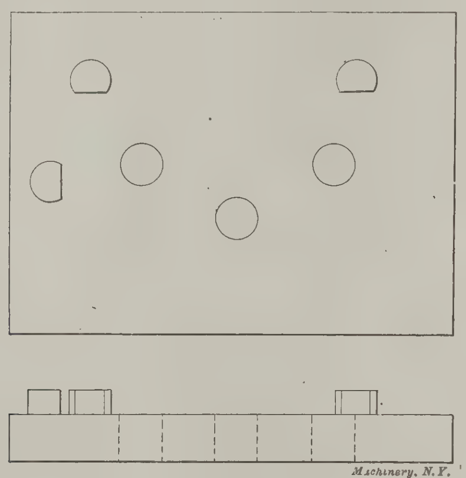
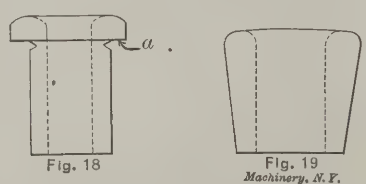


Fig. 17. Simple Form of Drill Jig without Bushings.



Bushings for Drill Jigs.

It is the custom in some shops to make the outer portion of bushings tapered, as shown in Fig. 19. Unless there is a sufficient reason for so doing, this is to be avoided, as the operation of making a tapered hole, unless it is bored on the taper with an inside turning tool, is not likely to produce a hole, the axis of which is at the desired angle to the surface of the jig. The outer portion of the bushing can easily be ground to the desired taper, but there is the liability of a particle of dust getting in the hole when placing the bushing in the jig. A tapered bushing, in order to get the proper taper, necessarily costs a great deal more than a straight one, and cannot answer the purpose any better, and probably not as well.

* * *

THE AUTOMOBILE SALESMAN AND HIS GOODS.

A. P. PRESS.

I send you a little yeast to lighten up the heavy matter; not that it is indigestible, but even a mechanic has more "wheels" than he can digest, sometimes. I am well aware that this is out of your line, and if you wish to throw it back on me, do not be afraid to do so; there will be no hard feelings.

You will remember I wrote you a year or two ago about the automobile (steam) salesman, and his expanding valve that kept the steam on the engine at any desired pressure, regardless of what the boiler might indicate, and also about his dividing line in the center of the boiler, so that if one-half burned out, you had the other half to come home on. I came across him again the other day; he was seated in a good-looking car of a well-known make, in the midst of an admiring crowd to whom he was extolling the virtues of the "auto."

"You see, boys, it is like this. This car ain't a circumstance to some of the new ones we are putting out, and while I ain't allowed to say much about it, I will say this: Our new model for 1908 is fitted with a chuck on the end of the engine shaft with lathe and mill attachment, so that no matter what happens, all you have to do is to put the drill in the same and make your own repairs, wherever you may be. Oh! I forgot to tell you; there is a vise, too, on the end of the tonneau. You see it makes you absolutely independent of any garage or machine shop. Then, the hydraulic cushions are new things——"

"Our new model for 1908 is fitted with a chuck on the end of the engine shaft with lathe and milling attachment."

"Pneumatic, you mean, don't you?"

"No! No! I mean hydraulic. Each cushion is made watertight and pumped up full. It makes the nicest seat you ever saw in your life. Then, it is connected with the cooling system from the radiator, so it keeps the seat cool in summer and warm in winter. I tell you what, it is great. Then, there is another one; we ain't saying much about it yet; it is for use out on the western prairies. It is fitted up with a cornshelling and bobbin-winding attachment. There is one farmer boy who has half paid for his, going around to houses and winding up bobbins at five cents per spool.

"One of the 'freaks' that we built on a special order is for a chicken fancier, who wanted to get clear of using gasoline. There is a large coop placed on the rear of the tonneau to hold about one hundred hens, and then every spoke in the wheel

is hollow. These are connected with a trap nest in the coop, so that the eggs run down through the hub and out into the spokes, just the same as that well-known 'perpetual motion' machine you have all heard about. The momentum of the eggs rolling out into the spokes keeps the thing going at a fair rate of speed."

"Yes," said one of the bystanders, "but what becomes of the eggs?"

"Catches them in a basket down at the bottom, and by the time he gets to town he has enough to pay for the automobile," said the salesman, as he slipped in his high gear and chugged away.

* * *

TABLET COMMEMORATING THE LOCATION OF THE HIDE AND LEATHER TRADES IN NEW YORK CITY.

The accompanying cut shows the bronze tablet mentioned in the business items for November, which was unveiled in New York October 27 in commemoration of the location of the hide and leather trades. This part of the city, known as the "Old Swamp," has been the home of the hide and leather trades for over a century. The site chosen for the tablet is the wall of the Schieren Building at the corner of Cliff and Ferry Sts., directly east of the Post Office. In the early days this locality was the site of numerous tanneries, these being the foundation of the present hide and leather industry in New York, and the industry still clings to this part of the

Bronze Tablet in the Wall of the Schieren Building, New York.

city, although the tanneries and the malodorous swamp have long since disappeared. The bronze tablet calls attention to the former existence of the tanneries on the site, stating that in excavating for the foundation of the building old tan vats were found in a good state of preservation containing tan-bark over one hundred years old. The tablet was unveiled in the presence of several hundred men connected with the hide and leather trades of New York and vicinity, and a luncheon was afterward served in the Schieren Building. An article on the Schieren Building and the manufacture of belting as conducted in the Schieren factory, was published in the May, 1906, issue.

* * *

It has become a custom with a great number of people to make an estimate of a country's prosperity from the amount of that country's exports. The fallacy of making an estimate of the prosperity of a country on such a ground is most easily apprehended if we compare the per capita exports of some European countries with the per capita exports of our own. There is no doubt whatever but that the general prosperity of the United States far exceeds the general prosperity of any European country, still the per capita exports of Germany and France have, at least up to the end of the last fiscal year, been both larger than the per capita exports of the United States. The per capita exports of the United Kingdoms are nearly twice as large, the per capita exports of Switzerland two and a half times, of Belgium three times, and of the Netherlands seven times as large as that of the United States. This seems to indicate that the country's prosperity does not entirely depend upon the amount of foreign exports, although this may be an important factor. It depends upon the internal conditions in the country, and American manufacturers do well in recognizing, that while the foreign trade may be an important item, the greatest possibilities for the building up of the industrial activities of this country are within the country itself. Whatever can be done to further our foreign trade is greatly important, but still more important is the establishment within our own borders of such conditions as will most greatly tend to increase the progress of our manufacturing.

SINGLE PULLEY DRIVES.

WM. F. GROENE.

The editor's request in Machinery several months ago for opinions on the "all gear" or "single pulley" drive, certainly relates to a subject on which discussion is timely. The question is one of the most important attracting the attention of machine designers to-day. The writer has recently made an extended tour through all the principal tool shops of the country, and with very few exceptions it is the opinion among builders and users that the single pulley drive will largely supersede the cone drive; and undoubtedly as soon as the present rush of business is over a great deal of attention will be given to tools of this design. Still for certain conditions it is doubtful whether we will find anything better than our old servant, the cone. The two principal advantages possessed by the single pulley drive are:

First, a great increase in the power that can be delivered to the cutting tool owing to the high initial belt speed. The belt speed always being constant, the power is practically the same when running on high or low speeds. The cone acts inversely in this respect; that is, as the diameter of the work increases, for a given cutting speed, the power decreases. As a second advantage, the speed changes being made with levers, any speed can be quickly obtained.

To these might be added several other advantages. The tool can be belted direct from the lineshaft; no countershaft is required; floor space can be economized. It gives longer life to the driving belt; cone belts are comparatively short-lived, especially when working to their full capacity. There are, however, some disadvantages to be encountered. Any device of this nature where all the speed changes are obtained through gears, is bound to be more or less complicated. The first cost of the tool is greater. There is also more waste of power through friction losses. A geared drive requires more attention, break-downs are liable to occur, and for some classes of work it cannot furnish the smooth drive obtained with the cone. Most of these objections, however, should be offset by the increased production obtained.

To the designer the problem presented is one of obtaining an ideal variable speed device, something that mechanics have been seeking for years with but poor success, and it is doubtful whether we will get anything as good for this purpose as the variable speed motor in combination with double friction back gears and a friction head. There are, it is true, some very creditable all-gear drives on the market in which the problem has been attacked in various ways. Still there is lots of room for something better. In the writer's judgment the ideal single pulley drive should embody the following conditions.

1. There should be sufficient speed changes to divide the total range into increments of say between 10 and 15 per cent.

2. The entire range of speeds should be obtained without stopping the machine.

3. Any speed desired should be obtained without making all the intermediate changes between the present and desired speed.

4. All the speeds should be obtained within the tool itself, and no auxiliary countershaft or speed variators should be used.

5. Only the gears through which the speed is actually being obtained should be engaged at one time.

6. The least possible number of shafts, gears and levers should be used.

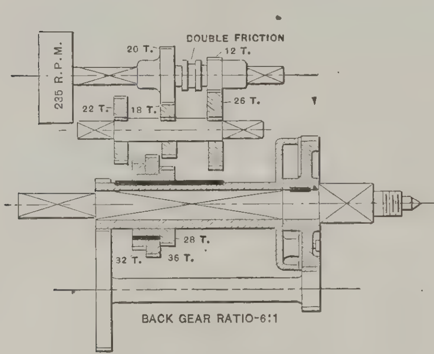
There are few subjects in machine tools which admit of so many combinations, arrangements and devices. The writer shows in Figs. 1 to 6 inclusive, some sketches taken at random from a large collection. All of these, except Fig. 6, have the number of teeth and the speeds marked. Each has some good points but none of them possesses all the points referred to above. The only excuse for publishing them is to show what a vast number of designs can be devised. One of them, that shown in Fig. 1, has been built, a number of machines have been running for over a year, and they give very good results. In Fig. 7 is shown the way the idea was worked out as applied to a 20-inch Le Blond lathe.

[The design for the headstock shown in Fig. 7 needs little explanation since the drawing shows the parts quite clearly.

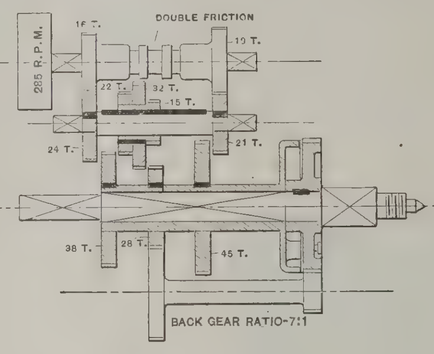
The friction clutch on the driving shaft Z, which alternately engages pinions H and J, is of the familiar type used in the Le Blond double back-geared milling machine. Sliding collar D operated by handle S moves the double tapered key E either to the right or left as may be desired, raising either wedge W or W', which in turn expand rings X or Y within the recess in either of the two cups, F and F'. Either of two rates of speed is thus given to quill gear K and the two gears L and M keyed to it. On the spindle is a triple sliding gear which may be moved to engage P with M, O with L (as shown in the drawing) or N with K, thus giving three changes of speed when operated by lever T. The six speeds obtained by the manipulation of levers S and T are doubled by throwing in the back gears, giving 12 speeds in all.

In comparing the merits of a series of gear drive arrangements like that shown in Figs. 1 to 6, how would it do to apply the "point" system in determining the most suitable one? The number of points that are to be assigned to a device for perfectly fulfilling any one of the various requirements outlined by Mr. Groene would be a matter requiring "selective" control is assigned 10 points. The fourth consideration, requiring that all speeds shall be obtained within the tool itself is a positive requirement. If it is not met, the mechanism is out of the contest, so this question need not be considered in our table of points. Fifteen points are suggested for the requirement that the gears not in use shall not be running in mesh. The sixth requirement reads "The least possible number of shafts, gears and levers should be used." It is suggested that this be divided, giving 20 points to the question of the ratio of the number of changes obtained to the number of movements required of the operator to obtain them, and giving the same number of points to express the ratio of the number of changes obtained to the number of gears used in obtaining them. The sum of these points added together is 100, which may be considered as representing the ideal design.

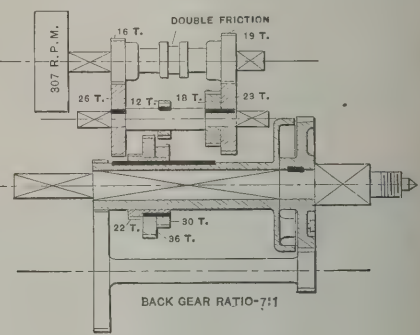
In filling out the table, since No. 1 has only 12 speeds or half the number required, we will give it only one-half the number of points, dealing similarly with the other designs up to No. 6, which is perfect in this respect. The machine has



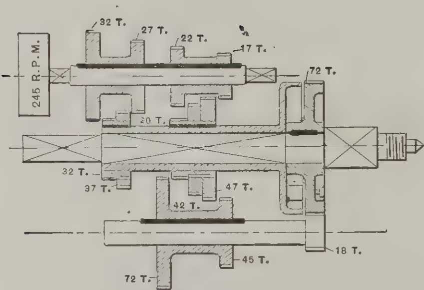
SPINDLE SPEEDS
B. GEARS IN-9.-12.4-16.7-21.6-29.76-40
B. GEARS OUT-54.-74.-100.-129-179-240
FIG. 1



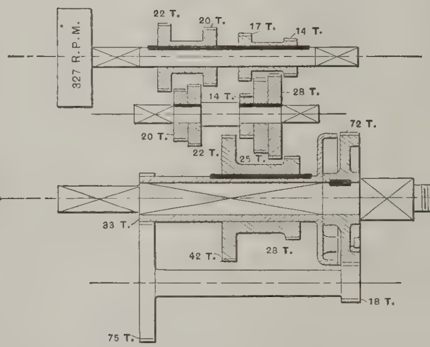
SPINDLE SPEEDS
9-12-16-24-32-48
63-84-112-168-224-336
FIG. 2



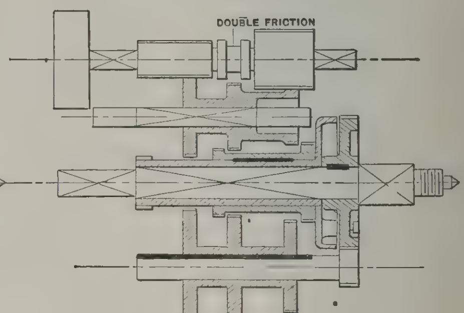
SPINDLE SPEEDS
9-12-16-24-32-48
63-84-112-168-224-336
FIG. 3



SPINDLE SPEEDS
B. GEARS OUT-6-8-11-16
1ST B. GEARS IN- 22-32-45-62
2ND B. GEARS IN-89-128-179-245
FIG. 4



SPINDLE SPEEDS
B. GEARS IN-6-8-11-14-18-25-33 40
B. GEARS OUT-54-72-95-136-164-222-297-359
FIG. 5



SPINDLE SPEEDS
24 SPEEDS OBTAINABLE,
NO DATA GIVEN
FIG. 6
Machinery, N.Y.

Six Examples of Possible Geared Head Arrangements selected at random from a large number of Similar Sketches.

nice discrimination. So the method outlined below is to be taken as being suggestive, rather than authoritative. Our contributor's first requirement is that there shall be sufficient speed changes to divide the total range into increments of between 10 and 15 per cent. The six schemes he proposes do not all, unfortunately for our proposal, take in the same range of speed; considering, however, that they were each to be designed to give from 9 to 240 revolutions per minute to the spindle as in case No. 1, and that a 15 per cent increment is to be allowed, the number of changes required can be found in the usual way by dividing the logarithm of 27—, the total speed ratio required ($240 \div 9 = 27$—) by the logarithm of 1.15, which is the ratio of the geometric series desired. This gives 24 speeds, about, as needed to meet the requirements. Suppose we assign 15 points to a machine having 24 speeds. Let us set this down in its proper place in the table, given on the following page. For the second qualification, that the machine shall not have to be stopped, we may assign 20 points to the ideal machine. The principle of to be stopped to throw in back-gears. Assuming that this would not have to be done in 70 per cent of the changes, we get a uniform value of 14 for this consideration for all the cases. The feature of selective control is only about two-thirds realized in any of these designs, since the triple sliding gear used in all of them, in moving from one extreme to the other, passes through an intermediate position which is not required at the time. We may therefore assign the value 7 to each of these designs on this account. As to the question whether the gears not in use are running idly in mesh, all the designs are nearly perfect. The values set down in this table are suggested by this consideration. In considering the number of movements required to effect the number of changes obtained, the throwing in of the back-gear is credited with four motions, the stopping of the machine, unlocking of the spindle from the gear, the throwing in of the back gears and the starting of the machine. The 20 points of the ideal machine are then multiplied by each of the ratios obtained by dividing the number of changes by the number

of movements and the number of points found are set down as shown. For the last item twice as many changes as there are gears employed is taken as a maximum which can probably not be exceeded. With this as a standard the ratio obtained by dividing the number of changes by the number of gears used is employed to calculate the number of points.

A SUGGESTED TABULATION OF THE MERITS OF THE VARIOUS DRIVES PROPOSED.

Requirements.	Perfect Design.	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
No. of changes required compared with No. obtained..	15	8	8	8	8	10	15
Stopping of machine........	20	14	14	14	14	14	14
"Selective" control........	10	7	7	7	7	7	7
Gears not in use, must not be in mesh	15	13	13	13	15	15	13
Ratio of No. of changes to No. of movements	20	15	15	15	13	12	14
Ratio of No. of changes to No. of gears.............	20	10	9	9	9	16	18
Total	100	67	66	66	66	74	81

Adding the number of points obtained in each column we find that No. 1 has 67, No. 2, 3, and 4 each have 66, while No. 5 has 74, and No. 6, 81.

The comparison has been undertaken in this way with the understanding that all the arrangements are susceptible of being embodied in a practicable design. That arrangement No. 6 is practicable is strongly to be doubted. Our contributor has not given us the number of teeth in the various gears used, and it is far from probable that he could obtain with this arrangement a series of speeds in geometrical progression by moving in regular order the three levers required. Nos. 4 and 5, while otherwise well arranged, are open to the objection that sliding gears rotating at high rates of speed are used. This, if valid, constituted a disqualifying objection similar to that mentioned in relation to Mr. Groene's fourth requirement. The first three cases in which a friction clutch instead of sliding gears is used on the driving shaft are therefore much to be preferred for this reason. Of these first three cases, our tabulation shows that case No. 1 has a slight advantage, and Fig. 7, in which this arrangement has been applied to a 20-inch lathe headstock, shows that the scheme is a simple and satisfactory one, so far, at least, as one can judge from a drawing.

As before remarked, the suggestion that the merits of these arrangements be tabulated and determined mathematically is a tentative one only and we are willing to withdraw it in the event of determined objections on the part of experienced designers.—Editor.]

* * *

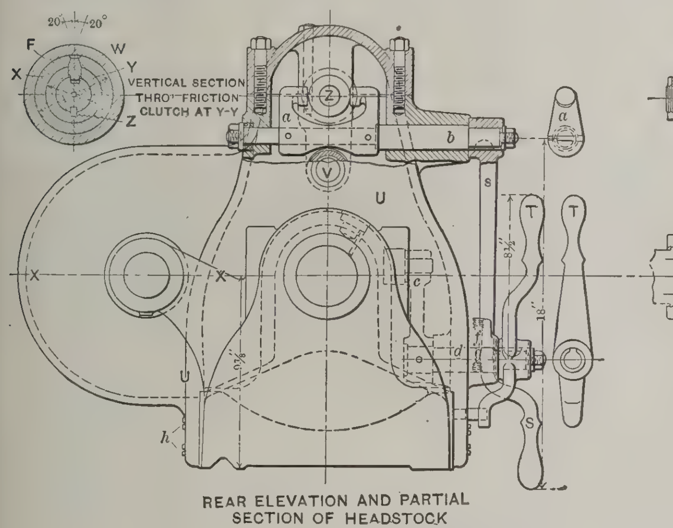
So far steam turbines of the Parsons type have been manufactured to give a total of 870,000 H. P. Of this 200,000 H. P. come on American builders, and 350,000 H. P. on the original Parsons' Works in England.

TAPPER TAPS.

ERIK OBERG.

The name tapper tap as understood by toolmakers and tap manufacturers is applied to one of the two kinds of taps used for tapping nuts in tapping machines. It is often confused with the expression machine tap, which properly designates the second kind of taps used for this purpose; the machine tap, however, differs from the tapper tap in a number of particulars, most important of which are the number and the form of the flutes, the relief of the threads and the general design. The tapper tap is the earlier of the two, and is simpler in its details. It is not adapted for the same hard usage as would be a machine tap, but is largely used for tapping nuts for general purposes in material which is not of too tough a structure.

The general appearance of the tap will be seen from the cut, Fig. 3. It consists of a threaded portion, *A*, chamfered on the top of the thread for a distance, *B*, and a shank, *C*, which as a rule is not provided with a square on the end,



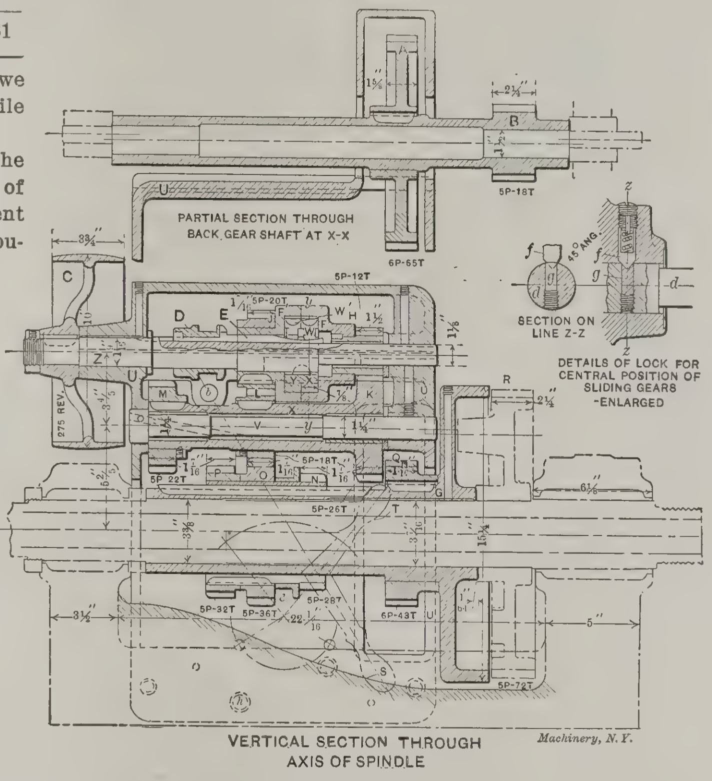


Fig. 7. The Scheme shown in Fig. 1 applied to the Headstock of a 20-inch Lathe.

this being unnecessary, because the tap is usually held firmly in a chuck by its circular shank. Some manufacturers using these taps prefer, however, to have the shank flatted on two sides, enabling them to secure a firmer hold on the tap in the machine. The diameter of the shank should be at least 0.015 inch smaller than the diameter at the root of the thread, in order to permit the threaded nuts to slide freely over the shank.

In turning and threading tapper taps, as well as any other taps, it must be remembered that the straight part of the threaded portion must be left a certain amount over the standard size. The screw which is to fit the nut threaded by the tap is usually made of a standard diameter, and the nut therefore must evidently be somewhat in excess of this in order to permit the screw to enter and to allow for slight unavoidable differences in the lead of the thread between the screw and the nut. The amount which a tap should thus be left over the standard diameter is largely a matter of judgment, inasmuch as this amount must vary according to whether a tight, free or loose fit is desired between the screw and the nut made by the tap. For general purposes, however, the tap should be made between the limits of from 0.0005 inch to 0.0015 inch oversize before hardening for sizes not over one-half inch diameter, from 0.001 inch to 0.002 inch for sizes between one-half and one inch, and from 0.0015 inch to 0.003 inch for sizes between one and two inches in

diameter. Tapper taps are rarely made in sizes larger than two inches. When larger diameters of taps are required for nut tapping, the taps should preferably be made on the principles of machine taps, the design and making of which the writer will return to in a later issue.

In fluting tapper taps it has been the practice to flute them practically the same as hand taps. It is, however, not necessary to make the lands as wide as on these latter taps, because there is not the same tendency for a tapper tap to deviate from its true course, the tapper tap being guided by the firm grip of the chuck, while a hand tap depends solely upon the lands of its threaded portion for guidance. The fluting of taps is one of the most important factors entering in their manufacture. The correct flute is a compromise be-

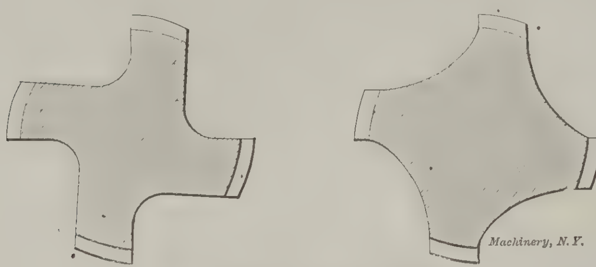


Fig. 1. Different Forms of Flutes.

tween a flute which will give the greatest amount of chip room and the greatest strength to the tap. Besides the flute must be of a shape easily produced, so as to limit the cost as far as consistent with good results, and must carry away the chips from the cutting edges in a manner offering the least resistance. The present practice is to provide tapper taps with deep straight-sided flutes having a small round in the bottom, as shown to the left in Fig. 1. This method, while it provides an abundance of chip room, is accompanied by some very grave disadvantages. The tap will crack more easily in hardening, it will not carry away the chips from the cutting edges as readily, and is not as strong as a tap fluted in the manner shown in the section to the right in Fig. 1. The making and maintenance of the cutters for producing this latter flute, however, is more expensive, and as the present practice of fluting is becoming fairly universal it is evident that the objections, while of a serious nature, do not outweigh the advantages gained. A tapper tap par-

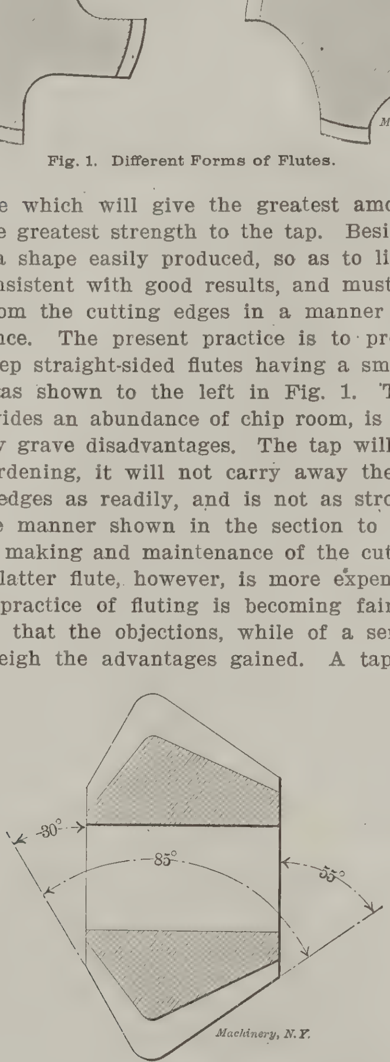


Fig. 2. Fluting Cutter for Cutting Flutes shown to the left in Fig. 1.

ticularly needs plenty of chip room because of its rapid cutting. The radius at the bottom of the flute ought, however, not be less than one-quarter of the diameter of the tap. Some persons well familiar with this kind of work claim that a radius of one-eighth of the diameter of the tap would serve the purpose equally well, besides giving a larger space for chips. It has been proven beyond doubt, however, that this slight difference in the radius at the bottom of the flute influences the endurance qualities of the tap very materially. In regard to the number of flutes there is some difference of opinion. The practice adhered to by prominent tool manufacturers is to give four flutes to all taps up to and inclusive of one and one-half inch diameter, and five flutes for larger sizes. The fluting cutter for straight-sided flutes should have an inclusive angle of 85 degrees, 55 degrees on one side, and 30 degrees on the other, as shown in Fig. 2.

The next question of importance is the question of the relief given to the thread. Tapper taps as a rule are relieved only on the top of the thread of the chamfered portion. They are not given any relief in the angle of the thread. The straight part, which performs no cutting, being nothing but the sizing part of the tap, should not be relieved, or, if relieved, the relief should be very slight in order to permit the tap to retain its size so much the longer. It may be remarked that if the tap is backed out through the nut no relief at all should be permitted on the parallel part of the thread, because of the liability of chips getting in between the land and the thread in the nut, injuring tap as well as nut. In hardening these taps they should be drawn to a temper of 430 degrees F.

The accompanying formulas and a table figured from them give the common proportions of length of thread and length of chamfered part of tapper taps. The length over all depends solely upon the kind of work the tap is to be used on. It is the common manufacturing practice to make these taps 11 inches long over all. The formulas are based upon the diameter of the tap as this is the most convenient working factor. It may be objected that the length of thread should rather depend upon the pitch of the thread than upon the

DIMENSIONS OF TAPPER TAPS.

D	A	B	D	A	B
$\frac{1}{16}$	$\frac{5}{8}$	$\frac{1}{4}$	1	$3\frac{3}{4}$	$1\frac{1}{2}$
$\frac{1}{8}$	$\frac{7}{8}$	$\frac{3}{8}$	$1\frac{1}{8}$	4	$1\frac{9}{16}$
$\frac{3}{16}$	$1\frac{3}{16}$	$\frac{7}{16}$	$1\frac{1}{4}$	$4\frac{1}{4}$	$1\frac{11}{16}$
$\frac{1}{4}$	$1\frac{7}{16}$	$\frac{9}{16}$	$1\frac{3}{8}$	$4\frac{1}{2}$	$1\frac{3}{4}$
$\frac{3}{8}$	2	$\frac{3}{4}$	$1\frac{1}{2}$	$4\frac{3}{4}$	$1\frac{7}{8}$
$\frac{1}{2}$	$2\frac{9}{16}$	1	$1\frac{5}{8}$	5	$1\frac{15}{16}$
$\frac{5}{8}$	3	$1\frac{3}{16}$	$1\frac{3}{4}$	$5\frac{1}{4}$	$2\frac{1}{16}$
$\frac{3}{4}$	$3\frac{1}{4}$	$1\frac{5}{16}$	$1\frac{7}{8}$	$5\frac{1}{2}$	$2\frac{1}{8}$
$\frac{7}{8}$	$3\frac{1}{2}$	$1\frac{3}{8}$	2	$5\frac{3}{4}$	$2\frac{1}{4}$

diameter. This is true to a certain extent, but if we limit the formulas to standard thread taps, there will be no cause for errors, inasmuch as the number of threads is in all standard systems dependent upon and stands in a certain proportion to the diameter. In the table the values are given approximately as there is no reason to work closer than to one-sixteenth or even one-eighth inch in regard to length dimensions of this character.

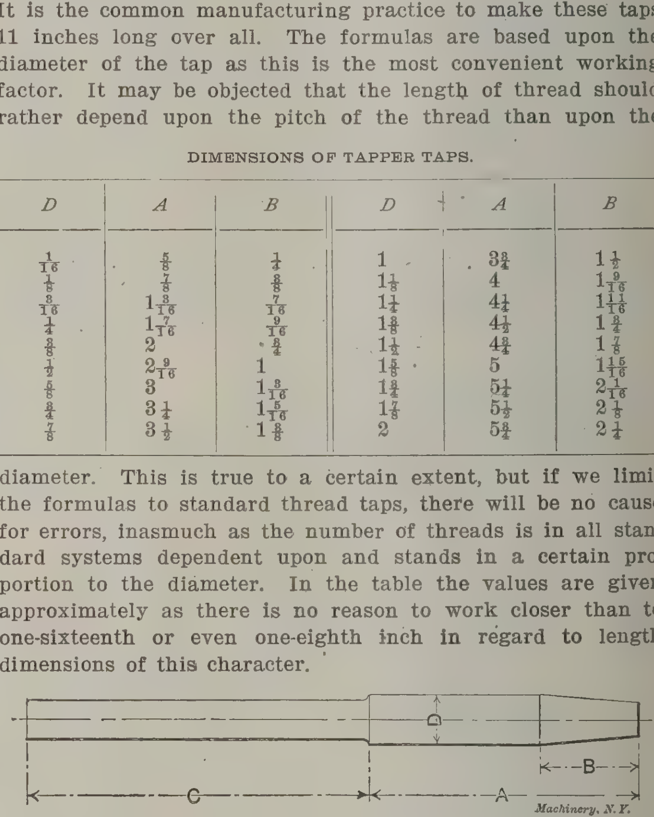


Fig. 3. General Appearance of Tapper Tap.

In the following formulas:

D = the diameter of the tap,

A = the length of the threaded portion,

B = the length of the chamfered portion.

For taps from 1/16 to 9/16 inch the following formulas are used:

$A = 4.5\,D + 5/16$,

$B = 1.75\,D + 1/8$.

For taps from ⅝ to 2 inches, use the formulas:

$A = 2\,D + 1\frac{3}{4}$,

$B = 0.75\,D + \frac{3}{4}$.

The diameter at the small end of the chamfered part should be from 0.005 to 0.008 inch below the root diameter of the thread on sizes smaller than ¼ inch in diameter, for sizes up to one inch about 0.010 inch below, and for larger sizes about 0.015 inch below the root diameter.

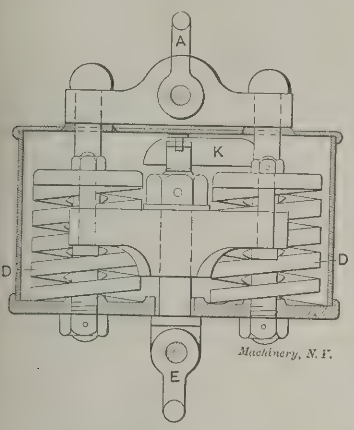
* * *

The bulletin of the Bureau of Labor for July is at variance with the generally accepted theory that prices have increased in a greater ratio than have wages during the last few years. This fact is proven by elaborate statistical tables. Whether the Bureau of Labor is right or not in its contention, may be open to discussion, but the fact remains that no statistical figures will be able to convince the salaried man or the wage earner that prices have not gone up out of all proportion to incomes.

ITEMS OF MECHANICAL INTEREST.

SAFETY DEVICE FOR CRANE CHAINS.

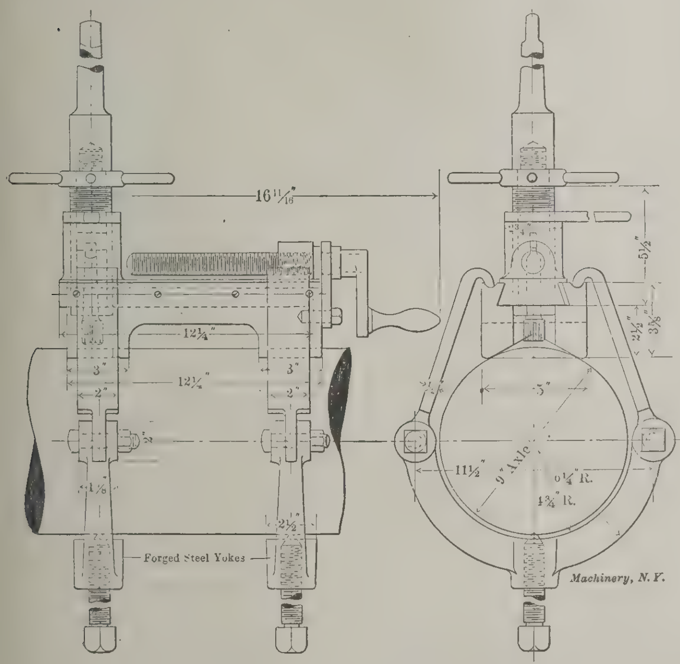
The accompanying cut shows an English device for preventing accidents due to failure of crane chains. These chains have, in many cases, been overloaded beyond their elastic limit, with fatal results. The cut shows an apparatus inserted at a convenient place in the chain, the upper portion of the chain being connected to the hook *A*, the lower to the hook *E*. By means of the springs *D* and suitable connections an electric bell *K* will give alarm whenever the chain is loaded beyond a certain limit, determined by primary adjustments of the springs and of the electric contacts. The springs, as is seen from the cut, are only in compression, so that any failure of the springs will not cause any damage, the load still remaining suspended. The principle of the design is plainly visible in the cut. The mechanism is dust-proof, being fully enclosed in a casing.



Safety Device for Crane Chains.

LOCOMOTIVE AXLE KEYSEATING DEVICE.

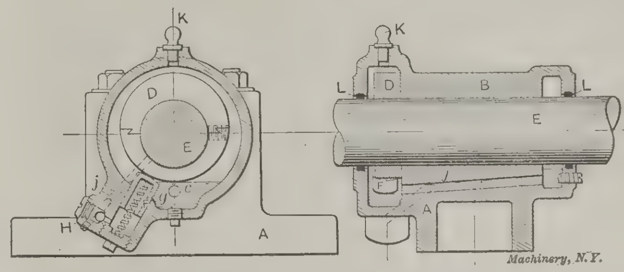
The accompanying cut shows a locomotive axle key-seating tool used in the shops of the Central Railroad of New Jersey, at Elizabethport, N. J., and depicted in the *Railway Master Mechanic*. As seen from the cut the device is fastened to the shaft in which the keyway is to be cut by means of two clamps, each consisting of a steel yoke and two clamping arms, these clamps holding the base of the device in position. A slide is provided which by means of a feed screw is moved back and forth in this base parallel with the axis of the shaft in which the keyways are to be cut. This slide carries a spindle bored to receive the Morse taper shank of an end mill, the spindle itself being provided with a Morse taper shank and driven by an air motor connected by a flexible shaft. The device has provisions for adjustments in all directions necessary. The cut shows plainly the design in detail. The usefulness of this tool will be appreciated by anyone who has had to cut out keyways for eccentrics in a hard steel axle, using a hammer and chisel and perhaps doing the job under the engine at that.



Locomotive Axle Keyseating Device.

A SHAFTING HANGER WITH FORCED LUBRICATION.

At the Olympia machine exhibition, which has been in progress for some months in London, Messrs. Geo. Richards & Co., Ltd., of Broadheath, Manchester, have been showing a pair of swivel adjustable bearings, using a method of self-lubrication, which is illustrated in the line cut of the pillow block shown herewith. *A* is the main casting of the block and *B* is the cap. The bearing formed by *A* and *B* has an annular recess at each end connected by the duct *c*. One of these recesses forms a chamber in which revolves split collar *D*, which is made fast to shaft *E* with a setscrew and forms one of the collars of the line shafting. The periphery of *D* is eccentric, and plunger *F*, which works in a hole in casting *A* and is pressed against *D* by the action of a stout spring, is constantly given a reciprocating motion. *F* is the piston or plunger of the pump which distributes the oil. At the extremity of its upward stroke, ports *g* are in communication with the reservoir of oil furnished for the supply of the bearing. This oil, through the action of a previously produced vacuum below the plunger, is drawn into the chamber beneath it. As the shaft revolves and *F* is forced downward ports *g* are closed and the oil within the cavity is pumped out past ball valve *H* through passage *j* to the center of the journal, where it spreads over the entire bearing, to the extent that the journal and bearing are kept entirely out of contact with each other. A pressure gage applied to duct *j* registers from ten to twenty pounds per square inch, depending on the speed of the shaft. As the plug moves upward again under the influence of the spring, the vacuum formed beneath it draws in a fresh supply of oil as soon as ports *g* are opened. The supply of oil is renewed through plug *K*. The bearing is made dust-proof and oil-proof by the insertion of leather washers *L L* at the ends of the bearing. The chamber for the supply of oil has sufficient capacity to lubricate the bearing for several months without any further attention.



Shafting Hanger with Forced Lubrication.

* * *

ADAPTING MACHINERY TO THE CAPACITY OF PACK ANIMALS.

One of the problems that sometimes confronts the machine designer is to make the construction so that no part shall exceed a weight of, say, two to three hundred pounds, or that which can be carried by a pack animal. This applies, of course, to mining machinery which has to be transported over mountains and into unsettled parts where roads have not been built. In some cases, however, it taxes the ingenuity to provide this, especially where the machinery is of such a nature that it must necessarily be integral. For example, the steel cables for hoisting have to be transported in full length as much as possible to avoid the defects of splicing. In such cases the matter is up to the manager of the pack train, but the method followed is very simple in scheme, although not always simple in the carrying out—if some of the animals are evil-disposed. It consists simply of uncoiling the cable and recoiling it at intervals to the required burro load, then leading to the next animal, where another coil is gathered, and so on until the whole cable is distributed among as many as are necessary to carry the total weight.

* * *

The postal department in Bulgaria has introduced automobiles for local transfer of mail, and found them to be of great advantage as well as economical for this purpose. It is proposed to extend the employment of automobiles to rural mail routes.

Entered at the Post-Office in New York City as Second-Class Mail Matter.

RAILWAY MACHINERY

A SPECIAL EDITION OF MACHINERY FOR THE RAILWAY SHOP, DEVOTED TO LOCOMOTIVE AND CAR EQUIPMENT AND MECHANICS.

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We solicit communications from practical men on subjects pertaining to railway machine shop practice, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

DECEMBER, 1906.

WILL THE STEAM TURBINE BE USED ON LOCOMOTIVES?

When asked the question "Will the steam turbine be used on locomotives" it is unwise to make a negative answer. In all probability the idea will be tried—in fact we believe it has already been experimented with—but in the light of present knowledge there does not seem to be much encouragement for the use of the steam turbine for locomotive practice. In the first place the steam turbine only develops good efficiency when run in connection with a condenser, and this, obviously, is impossible with the locomotive. In the second place the gyroscopic effect of heavy masses, with horizontal axes, revolving at high speed on a locomotive would likely be serious in rounding curves at any but a moderate pace. The suggestion of providing two turbines running in opposite directions in order that one might offset the effect of the other, is unsound. The tipping effect or resistance to change of plane should be the same for the same weight and speed of revolving parts. Add to this the effect on the bearings of the resistance to change of plane, and the situation becomes extremely unpromising, especially when it is admitted that dynamos and motors must be interposed between the turbines and the drivers.

* * *

FALLACY OF THE "LOOSE WHEEL" AXLE.

One of the principal retarding factors in railway train operation is the frictional resistance of the trucks in rounding curves. This retarding effect is made up of flange friction against the outer rail, pivot and side-bearing friction, and the slipping of the wheels on the outer and inner rail, caused by the rigid connection of the wheels to the axle. To avoid the rigid axle connection of railway car-wheels, has been the object of numerous inventions, all of them practically worthless on account of the cost and complication introduced. But it is not generally known that this very feature of rigidity of connection is useful in keeping the trucks parallel with the track, paradoxical as it may seem. Some years ago the Sixth Avenue elevated railway in New York City tried a "loose wheel" truck with very unsatisfactory results. The truck had the serious defect, aside from its complication and high first cost, of being very easily slued on the track with the consequent ever-present danger of derailment. Any slight obstruction on one of the rails such as sand, snow, ice, etc., tended to make one wheel run behind the other and turn the truck at an angle. This obviously is something that does not happen with the rigid wheel construction which, consequently, becomes a really valuable feature. Notwithstanding its retarding effect on curves, it is probably safe to say that the rigid axle connection between opposing car-wheels is something that will never be changed. It has the merit of cheapness, simplicity and, as just pointed out, of preserving the alignment of the truck with the track. The principal objection to rigid connection—the resistance to rounding curves—is partly disarmed by coning the tread. Another point is that with a revolving axle the journal constantly tends to wear to a full bearing in its brass, while on the other hand a wheel revolving on a stationary journal always tends to wear out of full bearing.

* * *

EXTRA COST OF THE WALSCHAERTS VALVE GEAR.

At the September meeting of the New York Railroad Club the statement was made by one of the speakers that the locomotive builders charge fully $1,000 more for a locomotive equipped with the Walschaerts valve gear as compared with the same locomotive equipped with the Stephenson gear. We have since learned that this statement is not entirely as it appears on the face. It is true that more is charged for the Walschaerts valve gear, but the sum is not as great as that mentioned. It is pointed out that while the Walschaerts gear is lighter in construction than the other so far as the working parts are concerned, it requires heavier cylinder castings, however. With the Stephenson gear using piston valves the shape of the cylinder casting is a nearly straight slope from the outside of the cylinder barrel to the smoke arch, but with the Walschaerts gear the piston valve is set over to come in line with the vertical plane of the gear and this adds considerable to the weight of the castings. The additional weight may easily be as much as 2,000 or 3,000 pounds. Another point to be remembered is that the design of locomotives with the Walschaerts gear is such as to admit of additional bracing between the frames, and this is taken advantage of, and, of course, it adds to the weight and cost.

* * *

AMATEURISH SCIENTIFIC INVESTIGATIONS.

A description of some experiments made by a French aeronaut has been going the rounds in the popular technical press. This ingenious Frenchman, Archdeacon by name, has applied an air propeller to a motor cycle, his object in doing this being, as it is stated, "to compare propellers of different shapes as to their efficiency." The motor cycle used weighed 154 pounds, and it was fitted with a V-type Buchet motor rated at six horsepower. The total weight propelled was 334 pounds and the time occupied in covering 1 kilometer was 45 2-5 seconds, a speed which corresponds approximately to 50 miles per hour. We are given information as to the method in which the motor was geared to the propeller shaft which was placed at the front of the machine. Details of the construction of the propeller are given and the statement is made that the propeller was injured prior to the test and only hurriedly repaired so that still better results are hoped for later.

In general an experiment of this sort is undertaken for the purpose of obtaining data on some particular subject; but the first thing this simple-minded aeronaut did was to cover the vital point of his experiment with a mass of confusing conditions which at once made any definite conclusions impossible. Why the motor cycle? And why its use on a public highway with its unknown conditions of roadway and wind velocity, with the necessary variable weight of rider and lost work in tires and propelling mechanism? It reminds one strongly of the old-fashioned method once said to have been followed in China for roasting pigs; the pig was tied up in the kitchen and the house set on fire.

Sir Hiram Maxim, some years ago, investigated this very subject of air propellers with highly refined apparatus. The fan or air propeller was mounted at the end of a revolving frame work whose resistance to movement through the air and about its pivot was reduced to a negligible quantity. Care was taken that the air in which the propeller revolved should be as nearly free and unaffected by outside conditions as it was possible to make it. From such experiments, with every variable eliminated except the design of the propeller and its velocity in revolutions per minute, it was possible to get a direct result in pounds, read from the dynamometer, or in surface speed, read from the revolution counter. Heaven only knows what definite results one could ferret out from the information given in the motor cycle test described above, but perhaps the experimenter's prime object was to get his name in the papers. If so, he has succeeded—as witness these paragraphs.

THE CORRESPONDENCE SCHOOL IDEA.

The celebration of the fifteenth anniversary of the International Correspondence Schools, October 16, at Scranton, Pa., marked a mile-stone in the progress of a great idea—technical education by mail. Like most great movements this started in a very modest way; it originated with Mr. Thomas J. Foster, then the editor of a newspaper in Shenandoah, Pa., who introduced a method of teaching a course by mail which was designed to enable the coal miners of Pennsylvania to pass the required examinations for mine foremen. It included special home study text-books and a system of direction and correction of students' work. The success of this work was immediate, and it led to the formation of many courses, there being now over 200 courses of instruction, covering almost every branch of all the well-known trades and professions. Over 300,000 students have either fully completed courses or have completed various subjects of a course.

The correspondence school idea appeals with special force to men who, as they have come to mature years, have realized their lack of education, especially on technical subjects. To many young men, unfortunately, the word education has an empty sound. It means little to them save perhaps a smattering of the three R's. Having no incentive to wider knowledge and, consequently, few or no ideals, they have drifted along until opportunities or family responsibilities have awakened them to a sense of their need. To such who are truly ambitious the correspondence school idea may be a great help. It opens the door to self-help and explains the way, making it so easy that the ordinary man of average intelligence who is able to read and write can gain a specialized knowledge and an understanding of the theory of his industry which will qualify him to be a leader in it rather than an inferior workman. The practical nature of the instruction and the fact that it treats of the business with which the learner is already familiar, has made this system of education a powerful factor in the general uplift.

* * *

THE ROTARY GAS ENGINE.

In the Engineering Review section of the November issue space was given to an abstract of an article on the above subject without editorial comment. The article was in favor of the gas engine, using the unsound arguments that have been used time and time again to bolster up the case of the steam rotary engine. The strongest feature of the rotary engine and one that always appeals most to inventors is the absence of dead centers and the fact that in the reciprocating engine there is a varying crank effort beginning at zero and increasing up to the maximum at about half-stroke position, then decreasing to the time of exhaust. The rotary engine is held to be free from this "defect"; consequently a great gain of mechanical efficiency is claimed. In the article noted the following unreliable statement is made, bearing out this claim:

"The greatest advantage of the rotary over the reciprocating engine would be, that the power of each impulse is applied constantly on the tangent; hence, the turning moment would be always equal to the pressure at any point, while in the reciprocating type the turning moment varies for small close-connected engines approximately as given in the accompanying table:

	Pressure.
Beginning of stroke	0.00
⅛ of stroke	0.444
¼ of stroke	0.668
⅜ of stroke	0.84
½ of stroke	1.00
⅝ of stroke	0.75
¾ of stroke	0.60
⅞ of stroke	0.44
Full stroke	0.00

"This variation is due to the imperfection of the crank and connecting rod as a means of power transmission. The above factors coupled with the constantly varying pressure, which falls rapidly after the beginning of the stroke, make the average turning moment only about 0.45 of the average pressure on the piston. *The rest of the pressure, about* 0.55, *is simply lost in strains and friction.*" (The italics are ours.)

To quote Josh Billings, "this is 2 mutch." Did the author stop to consider that although the crank effort does vary substantially as claimed, the piston moves only about two-thirds the distance traversed by the crank, and that the volume swept up by the reciprocating piston is not more nor less than that swept up by the rotary piston for the same number of foot-pounds developed, neglecting friction? And, as to friction, the rotary engine is notorious in this respect. In fact it is the one great defect of the rotary engine, causing excessive wear and low mechanical efficiency. The prospects of success for the rotary gas engine seem even more remote than those of the rotary steam engine. What more could we say against it?

* * *

CONSULAR COMPLAINTS CONCERNING THE HANDLING OF FOREIGN TRADE.

There has appeared of late a great number of complaints from our consular service in regard to the manner in which American manufacturers treat their foreign customers and handle the export trade. These complaints seem to indicate that our European competitors are superior to us in every respect in regard to handling their foreign trade. Whether this supposition is founded on reasonable ground will be a second consideration. In fact it is impossible to review consular reports of any European country without finding that the consuls of those countries make similar complaints regarding the manufacturers of their respective countries. Instead of the American manufacturers solely being at fault it must be that manufacturers all over the world have not as yet acquired the ability of handling their foreign trade in the same expert manner as they take care of their domestic trade relations. We point out this fact, not with a view of impressing upon American manufacturers the opinion that inasmuch as the manner with which they handle their foreign trade may not be in any way inferior to the manner in which our European competitors handle theirs, they should feel satisfied with the results obtained and not try to improve, but simply because we consider that due justice ought to be given to our own country and its manufacturers. While there doubtless is good reason for improvements in many respects it does not seem justified to paint the American export trader fully as black as some of our foreign consuls have succeeded in doing.

There is, however, another complaint made by our consular service which we think to be far more justified, and which should not be disregarded by our manufacturers and merchants. Reports are frequently received from diplomatic and consular officers complaining of carelessness on the part of correspondents in the United States in failing to fully prepay the prescribed postage on letters and other mailable matter. This carelessness is not only annoying but is expensive to those receiving communications upon which the full amount of postage has not been paid, and has resulted in many cases in defeating the sale of American products abroad. It places an unnecessary burden on people who are making an effort to become acquainted with American goods and methods. Being compelled to pay penalties, even though small, does not tend to promote good feeling on the part of actual or prospective buyers. Under international postal agreements a penalty equal to double the amount of deficient postage must be paid by the party to whom the matter is addressed.

In offering a suggestion for overcoming the liability of mistakes in large establishments where all mail is handled by a special clerk it may be well to call the attention to the custom of several well organized houses who use special envelopes bearing the words "Foreign Mail" printed in the place where the stamp is to be affixed. This serves as a constant reminder to the mailing clerks that the domestic postage rates do not apply to the letters or packages so marked, and errors are thus easily avoided. Such a course might help to regain the good will of many foreign firms whose disaffection can be attributed to no greater and no other cause. The evil is evidently due to a lack of proper classification of mail matter in the offices of our merchants, and a simple method, like the one mentioned above, would probably prove to be an effective remedy.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

Two-cent letter postage for each half-ounce became effective between New Zealand and the United States on November 1. This arrangement will no doubt bring the two countries into closer business relationship.

Two months ago the first section of the Pekin-Kalgon Railway was opened which will, when completed, connect the Chinese capital direct with Europe and will bring Pekin within twelve days of London. The most remarkable feature in connection with the building of this railway is perhaps that it has been constructed entirely by Chinese men working under a native engineer.

It has been suggested several times in engineering history to make use of the tides by allowing them to fill diked-in territory, to run out again through turbines. It happens, however, that land that can be diked in is very valuable for dairy purposes, as the soft mud makes excellent soil, and much more can be netted from the land than from the power. —*Power.*

A remarkable opinion with regard to steam turbines finds expression in the words of Dr. Riedler at the Berlin meeting of the Society of German Engineers when in discussing the development of the steam turbine he found occasion to say: "The turbine is no longer the motor of the future; it is the steam engine of the present." This opinion has so much greater weight, as Dr. Riedler himself has attained much of his professional eminence by reason of his success in the improvement of reciprocating machinery.

An interesting employment of paper relates to the production of gas-pipes. Manila paper cut in strips, of a width equal to the length of the pipes to be made, is put in a receiver filled with fused asphalt and rolled solidly and uniformly around a rod or core of iron until the desired thickness is obtained. After the pipe thus produced has been submitted to heavy pressure, the exterior is covered with sand and the whole cooled in water. The core is removed and the outer surface covered with a waterproof product. These pipes, it appears, are perfectly tight and more economical than metal pipes.—*The Mechanical World.*

Two parts of aluminum and one part of zinc form an alloy to which has been given the name "alzene." It is equal in strength to good cast iron and superior to it in the matter of elastic limit. It takes a fine smooth finish and does not readily oxidize. The color is white. It melts at a low red heat, and is very fluid, running freely to the extremities of the mold and filling small or thin parts. Great care must be exercised in melting it, particularly when mixing the two metals, in order to preserve its smooth working qualities. It is said to be somewhat brittle and hence unsuited to such pieces as require the toughness possessed by brass.—*Obermayer's Bulletin.*

The Giornale d'Italia, Rome, Italy, announces that the Midvale Steel Company, Philadelphia, has obtained from the Italian government an order for 2,100 tons of armor plate, valued at $1,000,000, for a man-of-war. The American company was in competition for the contract with five European firms, including the Krupps. Its tender was $180,000 less than that of the Italian Terni factory. Comments seem almost unnecessary, but it is evident that the time has passed when fiscal provisions are necessary in this country to keep foreign steel product out of the competition with our own steel mills. The above seems to amply indicate the latter's ability to successfully compete with European steel concerns even if "unprotected."

By reason of the ease with which the rotating member of a turbine revolves in its bearings, and the length of time that it will continue to run after the steam has been shut off, the frictional work of that form of engine is assumed to be very small. C. H. Wingfield calls attention to the fact that while there is no doubt about the friction *per revolution* being much less than in a reciprocating engine of equal power, the number of revolutions in a given time is much higher, and the friction of the turbine must be proportional to this greater number of revolutions before a comparison can be made. In other words, he asks, "Is the work expended per minute in overcoming friction less with a turbine than with a slower-running reciprocating engine of the same power?"—*Power.*

A two-cylinder 20-horsepower Maxwell automobile made a 3,000-mile run without its motor ceasing operation, the test ending in New York, October 31. The most of the mileage was made between Boston and Worcester, the round trip being 88 miles. This route was covered by two drivers, alternating at the end of every two trips. Then, in continuation of the run the car traveled to New York, back into Connecticut and again to New York, so as to complete the 3,000-mile distance. For fuel and lubrication 161½ gallons of gasoline, at 20 cents per gallon; 24¼ quarts of lubricating oil, at 20 cents per gallon; and 5 pounds of grease, at 15 cents per pound, were used. Other minor expenses brought the total nominal cost of operation for 3,000 miles up to $41.45.

As was mentioned in an article describing the new shops of the Western Electric Co. at Hawthorne, Ill., in the July issue of MACHINERY this company has provided storage bins for coal so arranged that the coal may be kept stored under water, this for preventing loss of heat units and spontaneous combustion. For the storage bins a plot 320 x 75 feet has been excavated to a depth of about 12 feet and lined and sub-divided by concrete walls into twelve 80 x 25 feet pits. The bottom is clay subsoil and the walls are carried about 4 feet above the ground. The pits can be flooded by means of a 12-inch water main. The longitudinal division walls are wide enough to carry the tracks on which the coal is delivered. It is removed from the pits by a steam shovel.

There has of late been a number of different formulas proposed for the rating of automobile motors. The Automobile Association of Central Europe has adopted a formula for four-cycle motors based upon a mean pressure of about 55 pounds per square inch and 900 revolutions per minute. This formula reads $N = 0.003\ id^2s$, in which N equals the number of horsepower to be determined, i the number of cylinders, d the diameter of the cylinders, and s the stroke. All dimensions are given in centimeters. If the dimensions are given in inches the formula would be $N = 0.0492\ id^2s$. The output as figured from this formula is rather low, however, depending upon the low mean effective pressure upon which the formula is based.—*The Horseless Age.*

After the great San Francisco fire, hundreds of tons of lead, zinc, and other metals owned by the Selby Smelting Company were found melted into a solid block at the base of the shot tower that was for many years one of the landmarks of the old city. The problem of recovering the metals, which were worth many hundreds of thousands of dollars, was a difficult one. The great mass could not be raised or broken up into fragments of a practicable size by any ordinary means. After removing several tons of bricks and débris, however, channels have been cut through the great block of metal by an electrical arc process. The bed of metal is from three to four feet thick, and covers the entire area of the ruins of the tower. The heat and light produced by the process are intense, though only ten volts are used for each implement. The men who are engaged in cutting the channels have their heads and faces covered with canvas to protect them from the blinding light. The metal is recovered in blocks weighing nearly a ton each.—*Scientific American.*

The opinion has frequently been expressed that Scandinavia, with its huge waterfalls, will before long be one of the most suitable places for large chemical works; indeed, it is claimed that with the future developments of electrochemical technology the greater part of the world's supply of soda, chlorates, nitrates, calcium chloride, and iron will be produced in the northern peninsula. Hence it is easy to understand the action of the Swedish and Norwegian governments in protecting the falls against foreign capitalists. Sweden has passed a law that the use of the falls is reserved to the State, while a bill is before the Norwegian Storthing in which it is prescribed that at least one-half of the capital laid out on the falls shall be Norwegian money, and the direction of the work be in the hands of Norwegians who are living in the land.—*London Nature.*

It is a common thing to find that many of our modern inventions and developments have been thought of a long time ago, but on account of various causes been forgotten. It may, however, surprise many, that a typewriter was invented and made two hundred years ago, during the reign of Louis XIV, in France, by one of his officials. The apparatus contained some of the principal details of our modern typewriters. Another fact of similar character is called to our attention by *The Engineering Magazine* for October, where we are told of the existence of a Scott graphophone in the "Musée du Conservatoire des Arts et Métiers" in Paris, the construction of which probably antedated the birth of Edison. Such cases do not decrease the honor of individual inventors, but only serve to prove that the human mind has constantly been active to solve certain problems which it has been reserved for our time to bring to a practical solution; that in fact, "nothing is new under the sun."

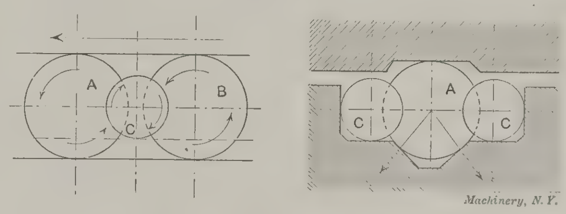
While the development of the use of steel cross-ties for railroad construction has not been very rapid in the United States, it may be of interest to know that metal ties were discussed in Germany as early as in the sixties, and that seventeen years ago nearly 10,000 miles of German railroad was laid with iron or steel foundation. In 1903, 11,500 miles of track were provided with metal cross-ties, this constituting more than one-fourth of the tracks in Germany. Indications point to the fact that the railroads in this country will before long earnestly consider a step of this kind for many reasons, among which we may mention the electrification of roads, necessitating a third rail and its supports, the abolishing of the grade crossings, calling for an abundance of viaduct work, and automatic train signalling which may call for a stronger support than can be provided for by wooden ties. It is evident that the expense of construction of railroads will increase with this improvement, but the traffic of the country is also increasing in such a degree that if the German railroads are able to afford this expense, there is no question but what the permanence of the track which this improvement would insure, will amply repay the railroads in this country for the increased amount of investment necessary.

THE CRYSTALLIZATION OF STEEL.

In an article in the *Iron Age* Mr. James H. Baker treats the subject of annealing and crystallization of steel. His statements in regard to the latter subject are very interesting. He claims that while there has been a great deal said about steel crystallizing when in use or when subject to vibrations and shocks, there is still room for doubt on this point. During experiments carried on by Mr. Baker, he has hammered steel for a long time cold and bent it back and forth slowly under a press until nearly destroyed, and on cutting and breaking the pieces there was no sign of crystallization. He claims that at times when steel used for industrial purposes breaks, as all things will when used enough, and its fractured area shows a crystalline structure, then it is always said to be "crystallized by use." But the fact is that the steel which when breaking shows a crystalline structure has been sent out from its place of production in a crystalline condition originally, and its use simply separates the faces of the crystals. Shortly, Mr. Baker seems to claim that there is no such thing as the crystallization of steel from shocks or vibrations. Cases where such occurrences have been suspected simply reduce themselves to a case where the steel has been defective from the beginning.

IMPROVED BALL BEARING.

The principle of spacing the individual balls of a ball-bearing by means of a second set of balls which carry none of the load of the bearing but serve only as spacers, has been applied in a new way by Mr. E. Denis, of St. Quentin, near Paris, France. Two sets of spacing balls are used, one on



Principle of Improved Ball Bearing.

each side, and tracks are provided for them to bring them central with the larger main balls. The sketch herewith, taken from *Le Genie Civil* shows the arrangement so fully as to require no further explanation. This form of bearing has been applied to the step-bearings of centrifugal dryers.

THE VALUE OF ALCOHOL FOR COMBUSTION ENGINES.

The Engineer, November 1, 1906.

With the enactment of the law on denatured alcohol, which is to take effect on January 1, 1907, experimental data on engines adapted to use this fuel are in order. The Model Gas Engine Works of Peru, Ind., have already had engines operating successfully with this fuel for a little more than a year. To adapt the "Model" engines for alcohol required no change whatever, with the exception of the compression, the fuel being admitted over a disk valve, thence passing through screens of perforated brass direct into the cylinder.

For its experimental work, the company used alcohol exported from Cuba. The company paid 10 cents a gallon, but was obliged to pay duty until it cost something over $3 a gallon delivered.

On trial it was found that alcohol was not nearly so volatile as gasoline, and therefore would stand a much higher compression. Various compressions were tried until a little more power was secured from a given sized engine than was possible with gasoline, the increase amounting to almost 10 per cent. The engine ran much more smoothly with alcohol, and there was no tendency for the heavy jar at the time ignition took place usually found in gaosline engines of high compression. This was accounted for largely in that the alcohol did not burn so rapidly.

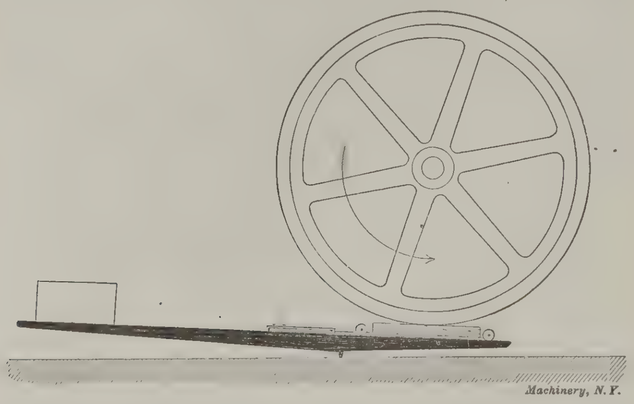
Very little difference was found in the consumption of alcohol as compared with gasoline. For the low grade alcohol which was tested the consumption was found to be approximately 1 gallon per horsepower for 10 hours, and this is practically the same result as secured with gasoline. Some writers are claiming that 1 gallon of alcohol will go as far as 2 gallons of gasoline for power purposes, but it is the company's belief that these people are not talking from actual experience, or have experimented with a higher grade of fuel than used by them.

It was also found that the engine would start practically as easily with alcohol as with gasoline, and was free from smoke and dirt. On the whole, the experiments seem to point out that alcohol is preferable to gasoline for power purposes with the gas engine, from almost every standpoint, where the price of both are equal.

A NEW DYNAMOMETER.

The Practical Engineer describes a very simple dynamometer recently brought out by an English concern. The object of the invention is to provide a measuring brake, which is portable and self-contained, and can be applied instantly to any engine or motor without previous preparation, and by which the power absorbed can be accurately and immediately meas-

ured with as little calculation as possible. This dynamometer, known as the Sellers, consists of a long lever carrying at one end a brake block running on small flanged wheels and attached to a spring balance fixed to the lever, as shown in the cut. The instrument can be used directly upon the flywheel. When not in use the brake is perfectly free of the flywheel, a great advantage when starting the engine or motor. The load is applied either by pressure of the foot or by placing



A New Dynamometer.

a weight on the long end of the lever, this weight being moved along to give a nice adjustment for steady running. There are no allowances or corrections whatever to be made, and by means of the table supplied with the spring indicator the power developed may be read off at once without any calculations.

THE STRENGTH OF IRON CASTINGS USED IN MACHINERY.

At the convention of the American Foundry Foremen, Professor C. H. Benjamin read a paper on the strength of cast-iron machine parts, in which he gave the results of many tests that have been made by him to determine by actual experiment the strength of castings of different forms. The information given by Prof. Benjamin will be found of decided value to designers, specially when engaged in developing some apparatus in which to save weight, or for some other reason, it is necessary to cut very close to the mark. In the following we have gathered what appear to be the most important parts of his address.

"In so simple a thing as a cast-iron beam of rectangular section, theory is more or less at fault in predicting the safe load. A series of experiments which I conducted several years ago showed me that the neutral axis of such a section was not stationary, but traveled gradually up from the center of gravity as the load increased. As the sections become more complicated the stresses due to the uneven cooling begin to appear and to still further embarrass the designer.

In the past dozen years I have conducted tests on a great variety of cast-iron members to determine the actual breaking load or pressure and compare it with that deduced by theory. There were tested in this way beams of various sections, cylinders, wheels, flat plates, gear teeth, pulley arms and rims, flywheels, rotary disks and high-speed pulleys of various types.

Cylinders usually break in a circular line just back of one of the flanges instead of splitting, as theory would indicate. Furthermore, the failures occur at pressure less than one-half those given by the usual formulas for their shells. This is probably due to pressure of blowholes or hot spots at the junction of shell and flange and to the bending moments caused by the pull of the cover bolts. Subsequent tests on cylinders whose flanges have been reinforced by brackets substantiate this conclusion. The cylinders all split from end to end under a pressure approximately two-thirds that given by the formula for their shells. The other third is accounted for by the bending due to lack of uniformity in the metal. A cylinder 10 by 20 inches, with a ¾-inch wall, would burst at a pressure of about 1,400 pounds per square inch, corresponding to a tensile stress of 10,000 pounds, whereas tensile tests showed the metal, a soft gray iron, to have a tensile strength of 14,000 pounds. Rectangular and square plates were tested, and the results were found to be remarkably uniform. The bursting pressure varied less than 10 per cent from that calculated by accepted formulas. The tests on gear teeth were made by applying a steady load on the testing machine, and were only conclusive as to the selection and not the absolute strength of different forms. The pressure was applied at various angles of obliquity, from 0 to 30 degrees, and two-pitch involute and cylindrical teeth were selected for experiments. The shapes varied from those of pinions to those of racks, and the following conclusions were reached:

1. The plane of fracture is approximately parallel to the line of pressure, and not necessarily at right angles to the radial plane.

2. Corner breaks are likely to occur even when the pressure is uniformly distributed.

3. Rack teeth are about twice as strong as those of pinions of 15 to 20 teeth, and involute teeth are from 40 to 50 per cent stronger than cycloidal.

The breaking pressure corresponded quite well to those calculated from the modulus of rupture of the iron used.

In testing the arms and rims of pulleys a steel belt was used, and a twisting moment thus applied to the pulley through the medium of levers and a testing machine. The pull on the tight side of the belt was graduated to twice that of the slack side, and the pulls were increased until one or more of the arms failed. The arms were slightly tapering and had twice the strength at the hub as at the rim. The fact that they broke sometimes at one end and sometimes at the other showed the ratio of the bending moments. The arm or arms nearest the tight side of the belt nearly always failed first, and we were justified in forming the following conclusions:

1. That on account of the springing of the rim the bending is unevenly distributed, so that about twice the average moment comes on the arm nearest the tight belt.

2. That the bending moment at the hub is about double that at the arm, as such pulleys are usually designed. The above ratios will be affected by variations in the relative stiffness of rims and arms.

Tests of Rotating Pieces.—The most fascinating and the most spectacular series of experiments have been those in which rotating pieces have been tested to destruction by high speed.

Wheels, models or flywheels without flanges were operated at a speed up to 400 feet per second, while those made in sections reached the speed of only 150 feet. Placing the joint close to the spoke did not appreciably strengthen the wheel, although steel tie rods between the joints and hubs increased the strength to some extent. English wheels, built on the bicycle wheel pattern, were the strongest wheels experimented with, giving a speed of 4,000 revolutions per minute. The large number of spokes permitted of no bending of the rim. All of the wheels experimented with were 24 inches in diameter.

A balance weight weighing 3½ pounds was located inside of the rim, and the wheel burst at 1,200 revolutions per minute. It should have withstood a strain of 2,000 revolutions.

From these tests we reach the following conclusions:

1. Any weight on the rim between the arms of a rapidly-rotating wheel, whether it be a flange, a balance weight or otherwise, is a source of weakness and danger.

2. When the weight is accompanied by a joint or any breaking of the metal at such a point the wheel is entirely unsafe at even ordinary belt speeds.

3. Solid rims of cast iron as ordinarily designed are almost entirely free from bending stresses, and will not burst at speed much less than 400 feet per second.

Tests on cast-iron disks have just been commenced, and so far the difficulties have been found greater than in any other series of experiments. The bursting speed of a disk is from one and a half to two times that of a ring, and this high speed, coupled with the severe shock of bursting, has affected the steam turbine used in making the experiments. So far three 18-inch disks have been burst at a speed of about 7,500 revolutions per minute. This corresponds to a rim speed of about 600 feet per second and to a stress near the center of about 12,000 pounds per square inch."

ANNEALING UNDER GAS.

Walter J. May, in *The Practical Engineer*, September 28, 1906.

Finished steel articles which have to be kept bright when annealed are rather difficult to deal with when charcoal packing is used, but when the annealing case or box is kept full of ordinary coal gas the trouble is overcome and the articles remain both bright and clean. The process is by no means an expensive one, while with ordinary care there is no danger attendant on working, no extremely high temperatures being required for annealing only. The quantity of gas used is small, as after the annealing case is filled, only a very small quantity need be passed through—enough to keep a No. 0 ordinary fish-tail burner alight being sufficient, and this would probably not be more than 2 cubic feet per hour. The time taken in the process of annealing from start to finish should not exceed two or three hours as a rule unless the articles dealt with were very heavy, and therefore it is scarcely likely that so much as 10 cubic feet of gas would be used in any one case.

Where the operator can regulate the heat it is possible to blue steel articles effectively, but as a rule this would require the use of a pyrometer, as a great number of men

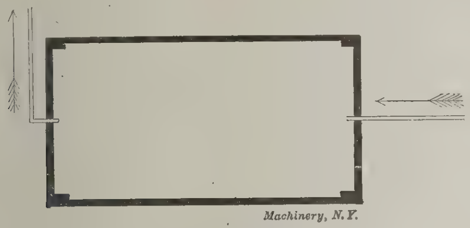


Diagram of Flask and Gas Supply for Annealing under Gas.

could not judge so low a heat as given from 520 degrees F. to 600 degrees F., as there would be no redness to go by. Clear mica sight holes might, of course, be used, but as the annealing flask would be dark inside, these would be of very little use in practice, while test wires would not advance matters much, as these would be blued before larger pieces of metal showed any change in color.

The method of heating the annealing flasks will be the one usually adopted in any particular place, but special flasks would have to be provided, whether they be of metal or fireclay. Probably those of cylindrical form would be best for many reasons, but this form is not absolutely necessary, as rectangular shapes may be more easily dealt with in some places. Anyhow, the same general plan for arranging the gas supply and the small exit pipe will be adopted, and this is approximately shown in the cut, each form of flask requiring its own special arrangement of fittings. Roughly, the flask is filled with the articles to be annealed, the cover luted on, and then it is placed in the furnace, after which the gas is connected and turned on, the air escaping by the exit pipe, which should be fitted with a No. 0 or No. 1 ordinary *iron* fish-tail burner. When the air has been driven out, the burner should be ignited and the supply of gas regulated to give just a small flame at the burner, and as the flask becomes hot probably a further reduction of the gas supply will be necessary. When the annealing is completed the gas supply will be disconnected, and the end of the supply pipe stopped, the exit pipe being stopped as soon as the flask is withdrawn, and then the whole can cool down before opening the flask, the articles not being exposed to the oxidizing influence of the air. Both for convenience and also economy in gas, it is well to have an *iron* stopcock on the exit pipe and an ordinary stopcock on the fixed portion of the inlet pipe, as by this means the flask can be sealed before it is taken from the furnace. This is a matter of detail which should be left to the common sense of the operator, however, and is scarcely worth mentioning where practical men are concerned.

Air must not be admitted to the annealing flasks while they are hot, or the gas will ignite, and under certain conditions explode with some violence, in which case damage would be done both to the furnace and to persons around, in all probability. All joints should be luted to prevent the admission of air as a matter of course, but the luting material will vary with the material of which the flask is made. The heat required for successful annealing, being between 1,300 and 1,500 degrees F., would be sufficient to ignite gas holding a certain proportion of air, but if air is not present the gas will only expand without ignition, and for this reason ordinary care must be used. Taken all round, for bright steel work, annealing under gas presents considerable advantages, but for rough work where finishing has not been done, the ordinary process is sufficient as a rule, and need not be deviated from unless for some special reason.

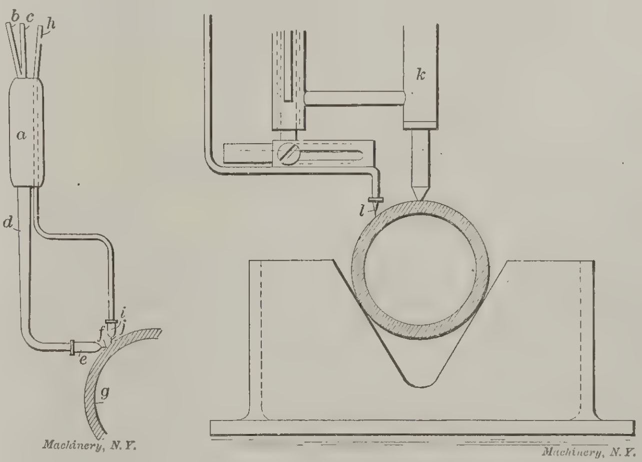
THE CUTTING OF STEEL BY THE COMBUSTION PROCESS.

S. D. V. Burr, *Iron Age*, November 1, 1906.

We are indebted to a Belgian engineer, Felix Jottrand, of Uccle, for the perfection of a process which, according to reports that have reached this side, is both rapid and economical and further is capable of wide application. The process depends upon the union of oxygen and iron and is founded upon the principle that when combustion has once been started it will continue as long as the proper conditions are maintained (see MACHINERY, Engineering Edition, July, 1906, page 590).

The first experiments were made with an oxy-hydrogen flame to bring the metal to a red heat; when this temperature had been reached the hydrogen supply was reduced and that of the oxygen increased, the idea being to produce combustion. It was found that this action was not violent enough; the oxidation was too slow, and the metal could not be made fluid enough to flow freely from the cut. Carried out in this manner the operation was intermittent. Combustion could only be maintained for a few seconds at a time and then the metal had to be again heated with the oxy-hydrogen jet. The kerf was of varying widths and its edges were rough, while the repeated heatings were too prodigal in the use of hydrogen.

Success was attained when two jets, one carrying the oxygen and hydrogen and the other the oxygen, were moved



Figs. 1 and 2. The Cutting of Steel by the Combustion Process.

along the mark. The first brought the metal to a red heat and the second provided the oxygen for combustion. The first jet was kept a short distance in advance of the second. Under these conditions the heat did not have time to be dissipated and the oxide was very fluid. Rapidity of cutting was assured, as the work was continuous. The expense of cutting was reduced, as there was no waste of gases, both the oxygen and hydrogen being used under the most efficient circumstances.

It is explained that the cutting of the metal is affected by a chemical action upon the heated part, the metal being raised to such a temperature as to enable oxidation to take place without fusion of the metal, while the oxides, which are more fusible than the metal itself, flow readily. The severance is perfectly clean as though the metal had been sawed.

The construction of the device will be understood from the accompanying illustrations, which are taken from the patent papers. When the work does not require any great degree of

precision, or when the contours to be cut are quite complicated, an ordinary blowpipe is employed, indicated at *a* in Fig. 1. This is provided with separate inlets *b* and *c* for the oxygen and hydrogen which open into the mixing chamber, *d*, from which leads the nozzle *e*, whence issues the heating jet *f* against the metal *g*. To this blowpipe is fixed the pipe *h*, which conducts oxygen under pressure to the nozzle *i*. This nozzle is arranged to follow closely in the path of the first, so as to direct its jet *j* upon that portion of the metal which has been brought to the proper temperature by the flame. This jet of oxygen produces a clean cut along the line and without appreciable loss of metal.

The second drawing, Fig. 2, shows the nozzles carried by a center *k*, which is applied to a pipe. It is evident that the same arrangement can be applied to a plate for circle cutting. Extending from the center is an arm at the lower end of which is a stud engaging with a slotted bar to which the gas pipes *l* are attached. By this means the device can be arranged to cut in circles of different diameters.

It is mentioned that the section cut is as clean as that left by a saw and the kerf is not over 2 millimeters (0.078 inch) wide in a plate 100 millimeters (3.93 inches) thick. The rate of cutting is 20 centimeters (7.87 inches) per minute for a plate 15 millimeters (0.59 inch) thick. The consumption of hydrogen and oxygen for this amount of work is only a few liters (1 liter = 61.022 cubic inches) of each. The line of cutting may follow any direction desired, and variations in the character of the metal have no influence on the cutting. The process is equally applicable to hard or soft steel and has been advocated for the dressing of armor plate.

HIGH-SPEED STEELS FOR WOODWORKING.

Iron Age, November 1, 1906.

Builders of woodworking machinery assert that they have demonstrated to their complete satisfaction that the high-speed steels are destined to bring about radical improvements in the woodworking industry, and some even go so far as to prophesy that it will be revolutionized in the near future. The tests made by one of the best-known and largest of the woodworking machine establishments brought out these general facts:

The rate of feed may be nearly doubled.

The cutting knives keep an edge from three to ten times as long as the old steels.

The knives may be ground with a better edge.

The sharpening of knives may be done to advantage without removing them from the head.

A slower speed of knife head is entirely practicable.

The most interesting and probably the most unexpected advantage obtained from the use of the new steels is the smoothness of the finish which they give to the work. This seems somewhat paradoxical to one who has employed them in working metal where they have been of little or no value in finishing work, though of exceedingly great importance in heavy or rapid production. Tests made, however, tend to show that in planing, for instance, it is possible to obtain, instead of a succession of knife marks, a clean, unmarred surface with a glossiness similar to that obtained in a sanding machine. Sample boards planed at the rate of 105 feet per minute showed this characteristic, and these boards included several varieties of both hard and soft woods. Sixty feet per minute is a high feed for carbon steels. Probably the reason for this better finish lies in the durability of the steel, which renders it possible to give the knives a keener edge with the knowledge that they will stand up to the work for a reasonable length of time. It is hoped by those who have experimented in this direction that under the new conditions still finer surfaces may be turned out by the planing machine at high rates of feed. As to the use of this steel for heavy reduction purposes, there should be some advantage in employing it as there is in metal working, but not so great a one. Here the old steels have been entirely satisfactory and seldom has a task been found beyond the temper of the cutting blades. For special purposes, such as in machining very hard woods, high-speed steel should prove valuable. As for the form of the knives, the toolholder is coming into vogue, the blades consisting of a thin, narrow strip, securely clamped to the head.

ELASTIC COUPLINGS.

Some kind of a spring drive has long been recognized as advantageous for machinery in which sudden and violent changes of resistance have to be overcome. The cut, Fig. 1, shows a coupling designed by Messrs. Rankin, Kennedy & Sons, Glasgow, primarily for use in motor cars and similar designs, and described in *Engineering* October 12, 1906. Its peculiar feature consists of a rubber disk for transmitting the power. This disk is provided with holes which receive

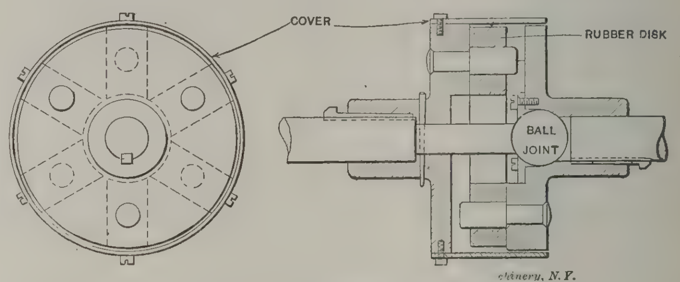


Fig. 1. Flexible Elastic Coupling.

the driving and driven pins projecting alternately from the faces of the coupling flanges. There are three pins in each flange. The flanges are prevented from longitudinal movement by a ball-and-socket connection. Consequently the shafts are free to adapt themselves to any want of alignment, but the ends cannot separate or close up on account of the ball joint. In motor cars where gear wheel transmission is used, the Kennedy coupler fitted to each end of the cardan shaft provides both a flexible and spring drive, and acts as a universal joint at the same time.

For chain drive the ball joint is dispensed with, as no flexibility is then required, and the coupling is designed as is

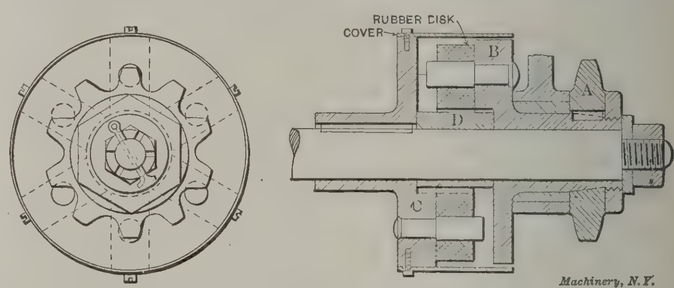


Fig. 2. Non-flexible Elastic Coupling.

shown in Fig. 2. Sprocket wheel *A* is fixed to the sleeve *B*, which turns loosely on shaft. The sleeve *C* is keyed to the shaft and each of the sleeves has three pins connecting them with the rubber disk. The collar *D* is inserted between the sleeves simply to keep them at a correct distance from one another.

UNIFORM NOMENCLATURE OF IRON AND STEEL.

At the Brussels Congress of the International Association for Testing Materials held in September, 1906, a report was presented on "The Uniform Nomenclature of Iron and Steel." The following definitions of the most important forms of iron and steel are given:

Alloy cast irons: Irons which owe their properties chiefly to the presence of an element other than carbon.

Alloy steels: Steels which owe their properties chiefly to the presence of an element other than carbon.

Basic pig iron: Pig iron containing so little silicon and sulphur that it is suited for easy conversion into steel by the basic open-hearth process (restricted to pig iron containing not more than 1.00 per cent of silicon).

Bessemer pig iron: Iron which contains so little phosphorus and sulphur that it can be used for conversion into steel by the original or acid Bessemer process (restricted to pig iron containing not more than 0.10 per cent of phosphorus).

Bessemer steel: Steel made by the Bessemer process, irrespective of carbon content.

Blister steel: Steel made by carburizing wrought iron by heating it in contact with carbonaceous matter.

Cast iron: Iron containing so much carbon or its equivalent that it is not malleable at any temperature. The committee recommends drawing the line between cast iron and steel at 2.20 per cent carbon.

Cast steel: The same as crucible steel; obsolescent, and to be avoided because confusing.

Cemented steel: The same as blister steel.

Charcoal hearth cast iron: Cast iron which has had its silicon and usually its phosphorus removed in the charcoal hearth, but still contains so much carbon as to be distinctly cast iron.

Converted steel: The same as blister steel.

Crucible steel: Steel made by the crucible process, irrespective of carbon content.

Gray pig iron and *gray cast iron:* Pig iron and cast iron in the fracture of which the iron itself is nearly or quite concealed by graphite, so that the fracture has the gray color of graphite.

Malleable castings: Castings made from iron which when first made is in the condition of cast iron, and is made malleable by subsequent treatment without fusion.

Malleable iron: The same as wrought iron.

Malleable pig iron: An American trade name for the pig iron suitable for converting into malleable castings through the process of melting, treating when molten, casting in a brittle state, and then making malleable without remelting.

Open-hearth steel: Steel made by the open-hearth process irrespective of carbon content.

Pig iron: Cast iron which has been cast into pigs direct from the blast furnace.

Puddled iron: Wrought iron made by the puddling process.

Puddled steel: Steel made by the puddling process, and necessarily slag-bearing.

Refined cast iron: Cast iron which has had most of its silicon removed in the refinery furnace, but still contains so much carbon as to be distinctly cast iron.

Shear steel: Steel, usually in the form of bars, made from blister steel by shearing it into short lengths, piling, and welding these by rolling or hammering them at a welding heat. If this process of shearing, piling, etc., is repeated, the product is called "double shear steel."

Steel: Iron which is malleable at least in some one range of temperature, and in addition is either (*a*) cast into an initially malleable mass; or, (*b*) is capable of hardening greatly by sudden cooling; or, (*c*) is both so cast and so capable of hardening.

Steel Castings: Unforged and unrolled castings made of Bessemer, open-hearth, crucible or any other steel.

Washed metal: Cast iron from which most of the silicon and phosphor have been removed by the Bell-Krupp process without removing much of the carbon, so that it still contains enough carbon to be cast iron.

Weld iron: The same as wrought iron; obsolescent and needless.

White pig iron and white cast iron: Pig iron and cast iron in the fracture of which little or no graphite is visible, so that their fracture is silvery and white.

Wrought iron: Slag-bearing, malleable iron, which does not harden materially when suddenly cooled.

THE MAZZA SEPARATOR FOR GASES—THE HIGHEST TEMPERATURE EVER ATTAINED BY MAN

Robert Kennedy Duncan, in *Harper's Magazine*, October, 1906.

Professor Duncan, who occupies the chair of Industrial Chemistry in the University of Kansas, contributed to the October *Harper's* a readable and instructive article on "High Temperatures and Modern Industry." A review is given of the increase in knowledge made possible by each increase in temperature afforded by successive discoveries, taking the reader from the bushwood fire of the savage, through the "good beach cole" of the alchemist, to the fiery furnace of the electric arc. Speaking of the importance of the oxygen blast in obtaining high temperatures, he thus describes two ingenious methods for obtaining it:

"As everybody knows, placing the 'blower' on the grate increases the per cent of oxygen passing over the fuel in a given time; it is the principle of the forced draft. But enormously better results may be obtained in another way. Since combustion depends upon the twenty-one volumes of oxygen in the air, why not increase its per cent by abstracting the inert and diluting nitrogen? This is being done to-day in two distinct ways. The first depends upon the use of liquid air. The boiling point of its constituent nitrogen is above that of its oxygen, and hence as its evaporation proceeds it leaves a liquid continuously richer in oxygen. Not only so, but Pictet and others following him have devised a "separator," by which the evaporating gases separate, because of their different specific gravities, in such a way that nitrogen passes off through one tube and oxygen through another. This method is one of completely demonstrated efficiency; it is attracting wide attention in France, and it may safely be predicted that in a few years it will enormously increase the output of the unit blast-furnace and high-temperature steels.

"The other method is a most curious one, and depends upon the hitherto unsuspected fact that it is possible to use centrifugal force in order to separate out a mixture of gases. The idea that with a revolving wheel it is possible to whirl out of the air nitrogen to one corner and oxygen to another seems almost absurd, and yet it is apparently capable of practical application.

"The 'Mazza Separator,' as it is called, contains a centrifugal wheel, which, revolving in the air at speeds from 1,200 to 2,200 a minute, is capable of concentrating the per cent of oxygen at the periphery. According to the experiments of Professor Schaefer, of the Technical School at Charlottenburg, the apparatus increases the per cent of oxygen in the air drawn from the periphery from twenty-one volumes to twenty-six. Again, according to an Italian firm of papermakers, who applied the separator to air furnished to their Cornish boilers, they saved throughout a month's working no less than 27.7 per cent of their coal. Of course, it is capable, also, of whirling hydrogen out of illuminating gas, and so increasing its luminosity; of whirling carbonic acid out of waste blast-furnace gas, thus making it more available for the new blast-furnace engines; and, in fact, if its actual industrial practice yields even a modest approximation to the enormous claims of its manufacturers, its use ought to result in striking economics in furnace practice."

As to the furthest point yet reached in the direction of high temperature, the author says: "According to a paper recently communicated to the Royal Society, Sir Andrew Noble has reached the highest point of temperature in terrestrial thermometry. He has accomplished this by exploding cordite in closed vessels with a resulting pressure of fifty tons to the square inch, and a temperature of no less than 5,200 degrees C. Sir William Crookes saw that one incidental result of this experiment should have been the formation of diamond—that is, if his calculations were correct. On working over the residues of the explosion chamber he has recently extracted from them small crystals that seem to be veritable diamonds. We see, then, that if men cannot control the conditions that make for large diamonds, they, at least, understand them. It is, in all likelihood, a matter of a comparatively short time when the diamond will have been conquered as absolutely as the ruby.

"With this final temperature of 5,200 degrees C. we have reached the limit of man's present attainment. On looking back, we see that every step in temperature he has so far taken has led him just so far along the path to universal conquest—the absolute conquest which he is destined ultimately to make. But in this phase of temperature alone he has far to go. We have had evidence from many sources that even in the sun, which is by no means the hottest of the heavenly bodies, and which yet possesses temperatures that transcend anything we know on earth, the very elements of matter lie there disintegrated into simpler forms. Such temperatures are the distant Alpine heights ever and ever so far higher than the slight ascent to which we have so tediously arrived."

ALUNDUM—ITS MANUFACTURE, CHARACTERISTICS AND USE.

Abstract of a description prepared by the Norton Co. in response to numerous requests.

No more remarkable advance in mechanical lines has taken place in modern times than the development of grinding. The field of the old grindstone was limited, and the sharpening of edged tools was almost its only use. But the introduction of the emery wheel made grinding a very important operation. The emery wheel has not only rapidly replaced the grindstone, but in many operations the work of the cold-chisel, the lathe tool, the file, and other steel-cutting tools is now done more efficiently by grinding.

Before the invention of the electric furnace, artificial abrasives suitable for grinding wheels were unknown. Wheel manufacturers necessarily depended upon natural products—chiefly corundum and emery. As emery occurs in considerable quantities in various parts of the world, it came to be recognized and used as the chief raw material for grinding wheels and other products employed in grinding metals. On this account the modern grinding wheel made of any abrasive is popularly known as the "emery wheel."

The Norton Company has during the past few years been operating an electric furnace plant at Niagara Falls, New York, in which has been developed and brought out a superior abrasive, known as alundum, and which is conceded to be one of the important electrochemical products made possible by the Niagara Falls power development. Eleven electric furnaces have been installed there, each capable of turning out three tons of alundum every twenty-four hours.

The process of making alundum consists in taking the purest amorphous oxide of aluminum found in nature, known as the mineral bauxite, and purifying and melting it in the electric furnace in a large, homogeneous bath or fluid mass. Upon cooling, this molten fluid solidifies and crystallizes in solid masses of alundum of great purity and absolute uniformity throughout.

Bauxite, the raw material from which alundum is made, is the purest naturally occurring amorphous oxide of aluminum known. This mineral was originally found at Baux, France, from which it derives its name, but purer forms are now obtainable in the United States. The best quality only is used in the manufacture of alundum, and in its preparation practically all impurities are removed. The high grades of bauxite used are of rare occurrence. The Norton Company, however, owns its own mines from which the purest grade is obtained.

The bauxite is heated in large preliminary heating furnaces to drive off the combined water, and is then melted directly in electric furnaces of special design. Bauxite was considered infusible until the invention of this process, no heat of combustion being able to melt it, the electric arc only being equal to this task.

The temperature, at which the furnace charge melts in one homogeneous mass, is above the limit by which temperatures are measured by any means known to science, and is variously estimated between 6,000 and 7,000 degrees F. The operation of these furnaces and the composition of the molten bath is under the control of the furnace operative. Exact quality and uniformity, which is so important in steel manufacture, is fully as important in the manufacture of alundum. The highest grades of steel are now being made in electric furnaces similar in design to the alundum furnace, because impurities can be removed at the high temperatures obtained by the electric arc, and the quality of the molten bath uniformly maintained. In the alundum furnace both the purity and uniformity of the alundum is assured. Each step in the process is under the close supervision of expert chemists.

The large masses of molten bauxite are allowed to cool and crystallize in great ingots of purified crystalline alundum. Beautiful crystals are found in the center of these masses, showing nearly all the variety of colors found in the ruby and sapphire, of which alundum is the commercial, artificial product. The rarer colors of light pink, blue and purple found in the rarer oriental gems are sometimes noticed in small crystals. The ingots of alundum are broken up into small pieces by means of powerful crushers. It is then passed through series of rolls to reduce it to the various sizes of grain, which are finally separated by passing over sieves of different mesh to prepare it for manufacture into Norton grinding wheels, rubbing and sharpening stones, etc.

The solid massive alundum, while resembling the purest natural corundum in chemical composition, has the remarkable quality of being considerably harder than the natural product. This is due to the perfectly fluid condition in which the mass is melted, the control of its composition, the rate and method of its cooling and crystallization by which it receives its temper, the absence of water of combination (which almost invariably exists in natural corundum), and the pure and even state in which the fluid mass crystallizes.

The introduction of alundum in the field of grinding has been remarkably successful and rapid. The requisites sought for and attained in this abrasive are extreme hardness and sharpness, combined with uniformity and proper temper. These, alundum has in the highest degree.

To have sharpness in order to obtain the most satisfactory results—so far as rapid and continued cutting is concerned—a peculiar quality is necessary. There must be a fracture which will give a number of sharp-cutting points. This is obtained in alundum to better advantage than in any other abrasive material.

In the matter of hardness the recognized standard is the diamond, which is No. 10 in the scale of hardness; nothing that man has yet discovered or made equals the diamond in hardness. The term "hardness" is, therefore, a comparative term, the hardness of a mineral being ascertained by its ability to scratch another mineral of a known degree of hardness, or to be scratched by such a mineral.

Pure crystalline corundum, represented by the best sapphire or ruby, has always been the standard of No. 9 in the scale of hardness. This is readily scratched by alundum; in fact, alundum powder is used for cutting and drilling rubies and sapphires for watch jewels, etc.

After numerous careful tests, comparing alundum grains with other abrasive grains, including the diamond, alundum is found to exceed 9½ in the scale of hardness where the diamond is 10.

By "temper" is meant its strength of grain and the character of its fracture under grinding pressure. An alundum grain is remarkably tough and will stand more crushing pressure before breaking than any other abrasive grain, but when it does break down it breaks with a sharp, crisp fracture, giving a fresh, keen-cutting edge. This is a most important quality in an abrasive.

The purity and uniformity of alundum far surpasses that of any other abrasive. Purity, besides resulting in greater hardness and better temper, is necessary in the bonding of the grain into wheels, in order to secure accurate and uniform results, and uniformity is necessary to secure constant efficiency and accuracy of grade and temper in a wheel, so that wheels can be accurately duplicated at any time and maintain their standard of work.

Uniformity is one of the most important requisites in an abrasive. The ability to duplicate a grinding wheel is essential to efficient results from its use. In grinding wheels the abrasive grain of given size is bonded together to produce a certain grade or temper for a certain kind of work. This means that the bond, which holds the grains together, must be harder or softer according to the particular work required of the wheel. Different grades are required for different materials to be ground; cast iron, steel, brass, glass, bone, leather, wood and other substances demand wheels of special grade which must be duplicated to make the grinding operation continuously efficient. It is for this most important reason that great stress is placed on evenness in quality of the abrasive itself. Grades cannot be duplicated accurately without having a known and dependable factor in the uniformity of the material composing the wheel; and this important requisite is to the highest degree found in alundum.

Alundum and the process of making it were awarded the Grand Prize at the St. Louis Exposition. The individuals responsible for its invention and development were honored with diplomas and medals for their part in this most notable, practical invention.

APPRENTICESHIP IN THE UNITED STATES.

Abstract of Report of Apprenticeship Committee of the National Machine Tool Builders' Association, 1906.

At the fifth annual convention of the National Machine Tool Builders' Association at the Hotel Breslin, New York City, October 9, Mr. E. P. Bullard, Jr., presented the final report of the Apprenticeship Committee, which had been directed to make a thorough analysis of the systems now in use throughout the United States, and to make suggestions for the guidance of the association in taking such action as might be advisable in the direction of uniform apprenticeship requirements. The following paragraphs give an abstract of the essential features of the report.

A series of letters containing fourteen questions was addressed to 51 machine tool builders and 41 other manufacturing concerns employing machinists. Replies were received from 49 machine tool builders and 26 from concerns engaged in other lines. The following were the questions asked:

No. 1. Do you indenture apprentices to the machinist's trade?

No. 2. Have such apprentices proven satisfactory from a commercial standpoint?

No. 3. What is the approximate ratio between the number of apprentices and machinists employed?

No. 4. Have graduate apprentices of your works been advanced to positions of authority while in your employ?

No. 5. Is difficulty experienced in securing a sufficient number of intelligent apprentices?

No. 6. Are applicants required to have a specific amount of previous school training?

No. 7. Are courses of instruction provided for apprentices during their term of service?

No. 8. Is attendance on these courses compulsory?

No. 9. Are apprentices under the charge of a special instructor while employed in the works?

No. 10. Are apprentices permitted to work on either the premium or piece-work systems?

No. 11. Are small tools provided for their use free of charge?

No. 12. Are inducements of either shorter time or increased pay offered to technical graduates to learn the machinist's trade?

No. 13. Do you indenture apprentices to the various branches of the trade, such as lathe work, planer work, etc.?

No. 14. Is any provision made for these special apprentices to become regular apprentices, should they desire, after having completed their special apprenticeship?

The following synopsis, taken verbatim from the report, gives the results of this inquiry:

1. The majority of Machine Tool Builders have established apprenticeship systems, which are in more or less satisfactory operation. A smaller percentage of the allied trades have some system, but one large industry, the automobile manufacturers, with one exception, employs no apprentices.

2. Apprentices have proven satisfactory from a commercial standpoint.

3. The approximate ratio between the number of apprentices and journeymen employed by The Machine Tool Builders is about 18 per cent, whereas the allied trades do not average over 13 per cent.

4. Graduate apprentices have been advanced to positions of authority in many shops. Some concerns state that their foremen come almost entirely from this class.

5. All reports indicate that difficulty is experienced in securing a sufficient number of intelligent apprentices. It seems, however, that the question of wages and time of service have little effect on this question.

6. But few concerns require a specific amount of previous school training, the majority requiring a common school education only.

7. As a general rule courses of instruction are not provided for apprentices.

8. Those who do provide such a course make attendance compulsory.

9. Apprentices are usually under the direct charge of the foreman of the department.

10. About 50 per cent of the concerns employing apprentices permit them to work under either the premium or piece work systems.

11. Thirty-three per cent provide small tools free of charge.

12. Thirty-three per cent offer special inducements to technical graduates, but state that they find it difficult to secure them.

13. Twelve per cent state that apprentices are taken to the various branches of the machinist's trade.

14. But a small percentage of the above make provision for special apprentices to become regular apprentices after having completed their special course.

This problem then resolves itself into the following:

Having an insufficient number of skilled workmen, we can only increase this supply by teaching the machinist's trade to an increased number of boys. Finding difficulty in procuring a sufficient number of boys for this purpose, we must offer inducements which will attract them to the trade.

We would therefore suggest: First, the drafting of uniform apprenticeship contracts, covering both regular and special apprentices, same to be binding both to the employer and employee, the former to be obliged to properly instruct the latter in the branch or branches of the trade specified in the contract, and we suggest that the articles of indenture provide sufficient guarantee on the part of the apprentice for the satisfactory completion of his time of service, the wages paid to be optional with the individual employer. We believe this point is essential, as it is apparent from our investigation that apprentice wages vary in different sections of the country. It would seem advisable, however, to have a uniform term of service in all cases to be based on the time found necessary, by previous experience, to properly teach the branch or branches of the trade specified in the contract.

The number of apprentices employed in any shop should be limited only by the ability of the employer to properly instruct them.

Graduate apprentices should be advanced wherever possible, and preference given them in making promotions.

Special apprentices or those indentured to one branch of the trade only should have a common school education, and regular apprentices, or those indentured to the full trade, to have at least a grammar school education.

Courses of instruction for apprentices during their term of service should be provided, where practicable, and attendance upon such courses, where provided, be made compulsory. High school and technical graduates should be exempt from special study during their term of service. A special instructor should be provided where practicable.

Apprentices should be permitted to work on the premium or piece work systems. All small tools should be provided for their use free of charge, these to be furnished new on completion of their trial period, and presented to them on the satisfactory completion of their term of apprenticeship. These tools should be inspected by an authorized official at stated intervals and the condition reported. These reports would be valuable in determining the interest and ability of the apprentices.

Technical graduates should be encouraged to indenture themselves to the trade by offering higher wages and shorter period of service. Influence should be brought to bear upon those in authority at the technical schools to impress upon them the demand in the machine tool business for men having a technical education and willing to learn the practical side of the business.

Indenture apprentices to the various branches of the machinist's trade, making the term of service short and wages relatively high. Offer bonus or reward for the satisfactory completion of apprenticeship.

Offer an opportunity for special apprentices to become regular apprentices, should they so desire on the completion of their special apprenticeship, the time so served applying on the regular apprenticeship course in proportion as may be thought advisable.

Finally, issue a diploma, bearing the seal of the National Machine Tool Builders' Association, to both regular and special apprentices, stating clearly the work accomplished during term of service.

STRENGTH OF GEARS.

JOHN S. MYERS.

The best solution of the gear problem is by use of the "gear slide rule," an instrument somewhat resembling Sexton's Omnimeter in appearance, which was developed by Mr. Carl G. Barth and placed upon the market in 1902. This device takes into account all the variable factors involved in a manner not practical for any table or chart. The writer does not offer the present article, with the accompanying diagrams, as affording so speedy or easily attained a solution of the problem, but more as an introduction to the special subject of bevel gears; the method of treatment of this phase of the subject here given being original with Mr. Barth and not heretofore published. The formula used for varying the stress according to the velocity was also developed by Mr. Barth, but upon submitting it to Mr. Lewis, he found it to be identical with one the latter had developed, but, to the best of the writer's knowledge, had never published.

The Lewis formula and the factors of strength for gears were presented to the public in 1893, and have been quite generally accepted as the standard for computations. The stresses for different speeds as first recommended by Mr. Lewis were only given tentatively in the absence of sufficient data upon which to base a definite formula expressing a mathematical relation. They have been found to agree fairly well with good practice, which indicates that, taken as a whole, they were approximately correct, notwithstanding some marked irregularities which are clearly evident by an inspection of the accompanying diagram, (see Plate III in the Supplement) where the dotted line represents Lewis's original table of stresses for different velocities. The formula devised to supplant this original table is as follows:

Let V = velocity in feet per minute at the pitch line of the gear;

S_s = allowable static stress in pounds per sq. in., *i. e.*, the allowable stress when the velocity equals zero.

S_v = allowable stress at the velocity V;

$$\text{Then } S_v = S_s \frac{600}{600 + V}. \qquad (1)$$

This formula gives a logical basis upon which to vary the stress according to the velocity, the value of S_s being chosen to suit the material used, class of workmanship and condition of service. In the diagram the three curves are plotted for S_s = 4,000, 6,000 and 8,000 respectively when reading on the bottom scale designated stress for cast iron, or, when read on the top scale for steel, the corresponding values of S_s are 10,000, 15,000 and 20,000. In the chart for strength of spur gears (see Plate II in Supplement) the column on the left gives the working load for gears of 1-inch pitch and 1-inch face, the stresses used being as given by the 8,000, 20,000 curve, and the column on the right working loads for stresses according to the 6,000, 15,000 curve, the former being approximately the values as originally given by Lewis, which are intended for first-class workmanship, the latter being ¾ of these values and applicable to a rougher class of machinery.

In order to give the scale of this chart representing the number of teeth a uniform appearance it was necessary to smooth out the inaccuracies of the Lewis strength factors by plotting them to scale and drawing a curve through the general direction. The explanation given in connection with this curve (see Plate I in Supplement) is sufficient to elucidate the method pursued.

To use the chart for strength of spur gears:

Case 1. To find the strength of a given gear; follow the vertical line representing the number of teeth to its intersection with the oblique line of the proper speed, and from this point follow the horizontal line to the left and read off the working load for 1-inch pitch and 1-inch face. Multiply this by the product of the face and the circular pitch and the result is the working load for the given gear, if the workmanship is good and the service not severe. If the contrary is the case use the working loads in the column on the right.

Case II. To find the proper pitch and face of a gear to carry a given load; proceed as before, going to left or right according to workmanship and service, and divide the given load by the working load for 1-inch pitch and 1-inch face. Make the product of the circular pitch and face of the required gear equal to this quotient. When using diametral pitch reduce it to circular pitch by aid of the table given with the chart, the first decimal place of these equivalents being sufficiently accurate for the purpose.

Example of case II: What should be the pitch and face of a 15-tooth, cast iron pinion running at a velocity of 1,000 feet per minute and transmitting a working load of 650 pounds at the pitch line?

By the chart, in the column on the left, the working load for 1-inch pitch, 1-inch face is 225 pounds, then 650/225 = 2.89 = product of pitch and face for the required gear. One-inch pitch and 3-inch face would fulfill the conditions with a margin of safety.

Going now to the subject of bevel gears, Mr. Lewis gives the formula

$$W = SPFY \frac{D^3 - d^3}{3\,D^2\,(D - d)}, \qquad (2)$$

in which

W = working load reduced to the pitch diameter at the large end,

S = allowable stress at the given speed,

P = pitch of teeth at large diameter,

F = face of gear,

D = pitch diameter at large end,

d = pitch diameter at small end,

Y = strength factor depending upon shape of teeth and formative number of teeth, this formative number of teeth being equal to $n \sec a = n\frac{L}{H}$, where n = actual number of teeth, a is the angle the pitch line makes with the center line; and L and H are the dimensions indicated in the sketch (see Plate IV in Supplement). He states that when d is not less than 2/3 D, as is the case in good practice, the formula

$$W = SPFY\frac{d}{D}, \qquad (3)$$

gives results almost identical.

If the above formulas be expressed in terms of the face F and the total possible length of face L they are then in a form which gives relative strengths for different face widths; and instead of expressing the limit of good practice in terms of the large and small diameters, which are only identical for both gears of the pair in the special case of miters, this limit is then stated by saying that the face width may be 1/3 L.

To express formula 2 in terms of F and L:

$D = 2\,L \sin a$ and $d = 2(L - F)\sin a$, then

$$\frac{D^3 - d^3}{3\,D^2\,(D - d)} = \frac{(2\,L \sin a)^3 - [2\,(L - F)\sin a]^3}{3\,(2\,L\sin a)^2\,[2\,L \sin a - 2\,(L - F)\sin a]}$$

$$= \frac{8\,(3\,L^2F - 3\,LF^2 + F^3)}{24\,L^2\,F} = \frac{L^2 - LF + \frac{1}{3}F^2}{L^2} = \frac{L - F}{L} + \frac{1}{3}\left(\frac{F}{L}\right)^2 \qquad (4)$$

We may then write formula 2 thus:

$$W = SPFY\left[\frac{L - F}{L} + \frac{1}{3}\left(\frac{F}{L}\right)^2\right] \qquad (5)$$

The quantity in brackets is the ratio of the strength of a bevel gear to the strength of a spur gear of the same pitch and face. This quantity may also be written

$$1 - \frac{F}{L} + \frac{1}{3}\left(\frac{F}{L}\right)^2$$

Since $1/3(F/L)^2$ is small compared to $1 - F/L$ when F/L does not much exceed 1/3 it may be neglected and formula 5 then becomes

$$W = SPFY\frac{L - F}{L} \qquad (6)$$

which is accurate enough for all practical purposes. This is shown clearly in chart 1 (see Plate IV. in Supplement) where the full curved line, plotted from the calculated values given in the table just above the chart, represents the correct ratio of strength while the straight dotted line gives the approxi-

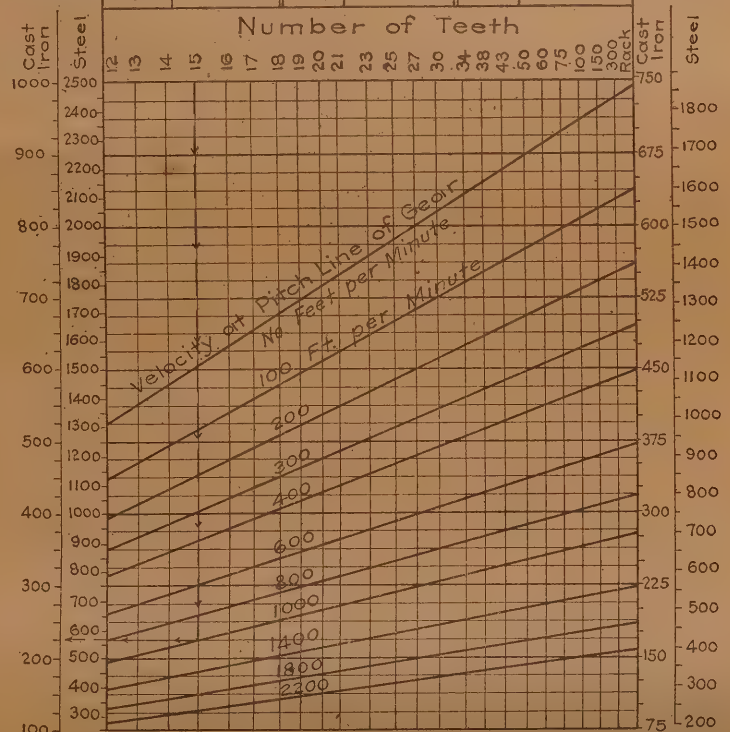
STRENGTH OF GEARS.—II.

15° Involute and Cycloidal Spur Gears

Based on Lewis's formula with strength factors slightly modified

To find the strength of a spur gear multiply the working load given in the diagram by the product of the pitch and face. Reduce diametral to circular pitch by table in which D = diametral and C = circular pitch.

D	C	D	C	D	C
1	3.142	2¼	1.396	4	.785
1¼	2.513	2½	1.257	5	.628
1½	2.094	2¾	1.142	6	.524
1¾	1.795	3	1.047	8	.393
2	1.571	3½	.898	10	.314



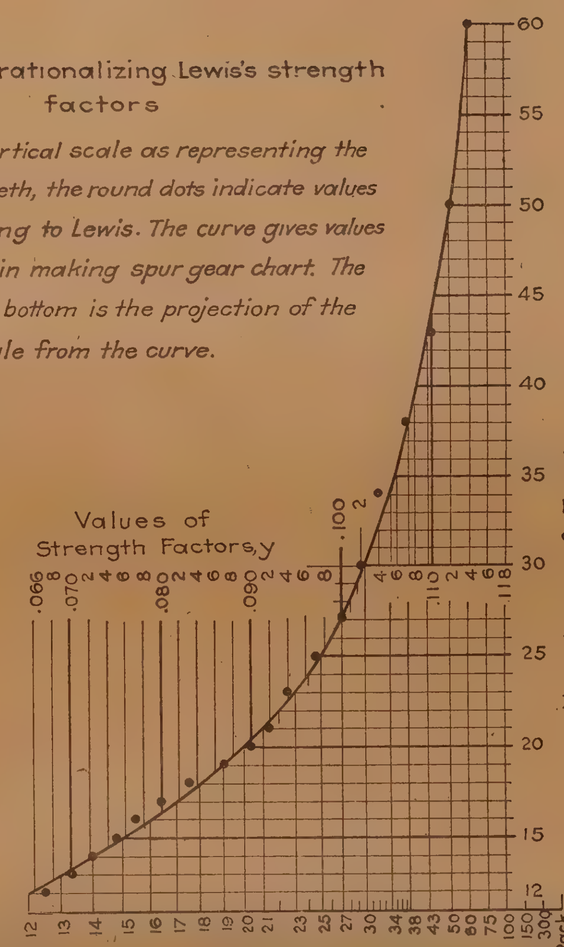
Example, 15 teeth at 1000 ft. per minute, working load = 225 # in cast-iron, for 1" pitch, 1" face

MACHINERY, N.Y.

STRENGTH OF GEARS.—I.

Method of rationalizing Lewis's strength factors

Taking the vertical scale as representing the number of teeth, the round dots indicate values of y according to Lewis. The curve gives values of y as used in making spur gear chart. The scale at the bottom is the projection of the vertical scale from the curve.



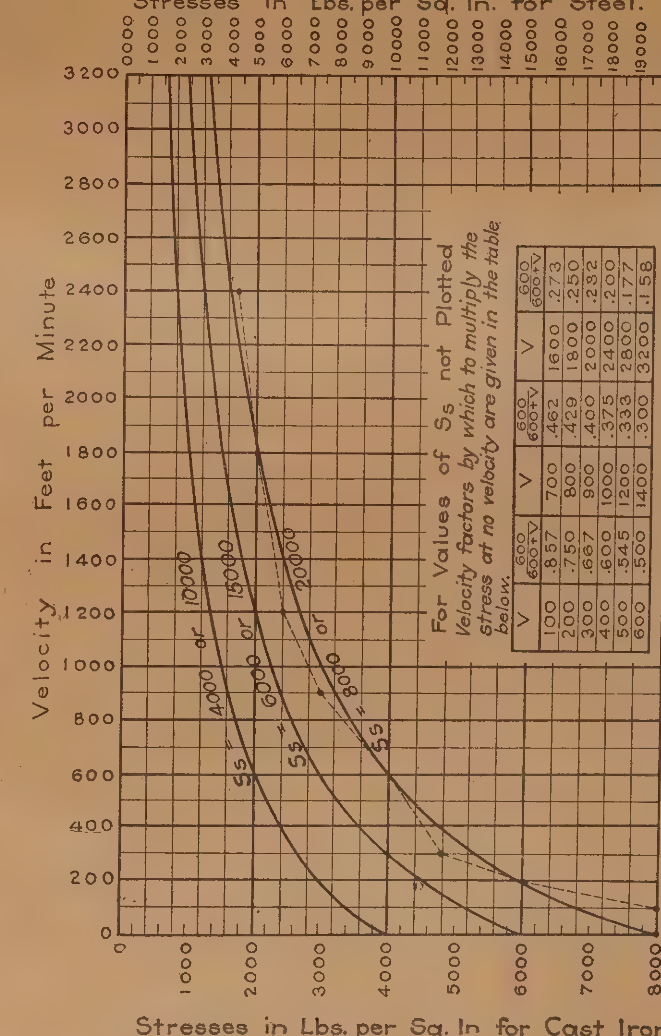
Scale used for number of teeth, in making spur gear chart, for 15° involute and cycloidal teeth.

MACHINERY, N.Y.

…number entitled, "Strength of Gears."

STRENGTH OF GEARS.—III.

Stresses for different Speeds



For Values of S_s not Plotted
Velocity factors by which to multiply the stress at no velocity are given in the table below.

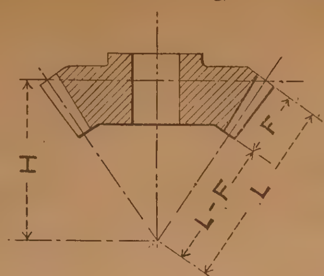
V	$\frac{600}{600+V}$	V	$\frac{600}{600+V}$	V	$\frac{600}{600+V}$
100	.857	700	.462	1600	.273
200	.750	800	.429	1800	.250
300	.667	900	.400	2000	.232
400	.600	1000	.375	2400	.200
500	.545	1200	.333	2800	.177
600	.500	1400	.300	3200	.158

The dotted line represents stresses as originally given by Lewis.
The curves give stresses according to the formula $S_v = S_s \frac{600}{600+V}$
where S_v = stress · for velocity V and S_s = stress when V=zero

MACHINERY, N.Y.

STRENGTH OF GEARS.—IV.

Strength of Bevel Gears.
According to Lewis and Carl G. Barth.



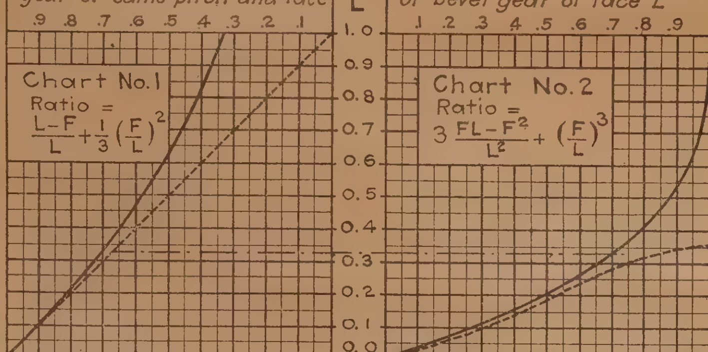
To find the strength of a bevel gear ; multiply its number of teeth by L/H and find the strength of a spur gear of this number of teeth and of the same pitch and face as the bevel gear; multiply the strength of this spur gear by the ratio given in chart No.1 below.

For face widths within the limits of good practice this ratio may be taken as equal to $\frac{L-F}{L}$

$\frac{F}{L}$	Ratio in Chart No.1	$\frac{F}{L}$	Ratio in Chart No.1	$\frac{F}{L}$	Ratio in Chart No.2	$\frac{F}{L}$	Ratio in Chart No.2
0.1	.9033	0.6	.5200	0.1	.2710	0.6	.9360
0.2	.8133	0.7	.4633	0.2	.4880	0.7	.9730
0.3	.7300	0.8	.4133	0.3	.6570	0.8	.9920
0.4	.6533	0.9	.3700	0.4	.7840	0.9	.9990
0.5	.5833	1.0	.3333	0.5	.8750	1.0	1.000

Ratio of strength of bevel gear to strength of spur gear of same pitch and face

Ratio of strength of bevel gear of face "F" to strength of bevel gear of face "L"



The dotted line indicates the ratio $\frac{L-F}{L}$ showing that for general use this is near enough to the true ratio for values of F/L not exceeding 1/3, which may be considered the limit of good practice

This diagram shows that when F/L = 1/3 there has then been developed .7 of the theoretical strength of the total cone.
The dotted line indicates the probable practical results, showing folly of making F more than $\frac{1}{3}$ L

MACHINERY, N.Y.

mate ratio $\frac{L-F}{L}$.

For $\frac{F}{L}=\frac{1}{3}$, the correct ratio $1-\frac{F}{L}+\frac{1}{3}\left(\frac{F}{L}\right)^2=1-\frac{1}{3}+\frac{1}{3}\times\frac{1}{6}$ $=\frac{19}{27}=0.7037$ and the approximate ratio $\frac{L-F}{L}=1-\frac{F}{L}=1-\frac{1}{3}=\frac{2}{3}=0.6667$, which is a difference of only $\frac{1}{27}=0.037$, or less than 4 per cent error for the greatest face widths used in good practice and this error is on the side of safety.

Chart 2 shows the ratio of strength of a bevel gear of face F to the strength of a bevel gear of face L. It thus indicates the proportion of the total possible theoretical strength of the entire cone developed by any given face. The formula may be developed as follows:

$$\text{Ratio}=\frac{\text{strength of bevel gear of face } F}{\text{strength of bevel gear when } F=L}$$

$$=\frac{SPFY\left(\frac{L-F}{L}+\frac{1}{3}\frac{F^2}{L^2}\right)}{SPLY\left(\frac{L-L}{L}+\frac{1}{3}\frac{L^2}{L^2}\right)}=\frac{\frac{FL-F^2}{L}+\frac{1}{3}\frac{F^3}{L^2}}{\frac{1}{3}L}=3\,\frac{FL-F^2}{L^2}$$

$$+\frac{F^3}{L^3}=3\frac{F}{L}-3\left(\frac{F}{L}\right)^2+\left(\frac{F}{L}\right)^3 \qquad (7)$$

Values of this ratio, as given in the table above the chart, were calculated and used in plotting the curve. It is to be noticed that this curve commences to change direction rapidly from $F/L=0.3$ and over. When $F/L=1/3$ this theoretical ratio $=0.7037$ and in practice there has probably been developed 0.9 or even 0.95 of the possible strength to be attained. This is indicated by the dotted curve which shows clearly that there is nothing gained by making the face over about $1/3\,L$.

It is believed by the writer that this method of treating the bevel gear problem has much to recommend it and he therefore takes pleasure in presenting it to the readers of MACHINERY.

* * *

"WILL THE AUTOMOBILE FOLLOW THE BICYCLE?"

The following letters are replies received in answer to an editorial on the above subject which appeared in the October issue. They will be found of interest as indicating a conservative attitude of the leading automobile manufacturers to their business and their ideas as to its permanency. The future of the automobile and its economic effect are matters of importance to us all, whether we are users or non-users. Mechanical engineers, in general, are heartily interested in its ultimate triumph, for it is in direct line with general mechanical development, but many have become disgusted with the uses to which the automobile has been put by wealthy users. The influence of road races, cross-country runs and other manifestations of the sporting class have been of little good. It is probably safe to say that few, if any, of the automobile manufacturers are satisfied with the present trend of affairs. They build automobiles for pleasure and racing purposes because this at present represents the best market, but they all recognize the fact that the future of the automobile largely depends upon its value for strictly utilitarian purposes. As to the present status of the bicycle, it will be apparent that some of the writers do not agree with the common impression that the bicycle is out of date, but they rather imply that the number in use at the present time is more than ever before.

From E. R. Thomas Motor Co., Buffalo, N. Y.

"The rise and decline of the bicycle was a phenomenon well within the memory of most readers. Will the automobile follow the bicycle?"

As a manufacturer of bicycles, I confess that the sudden decline of the use of bicycles was a severe and unexpected shock, and its quickly waning popularity was without a parallel, except roller skating.

It was patent to every bicycle manufacturer that the abnormal demand for bicycles created by intense competition and the most strenuous advertising could not continue forever. As long as radical improvements were made each year, that contributed to ease of running, light weight and beauty, it was an incentive sufficient to induce a large majority of riders to change their mounts annually.

The decline was further accelerated by an overproduction of cheap—almost worthless—wheels, riders continuing the use of their bicycles for two or more years, instead of only one when great annual improvements were the rule; the increase of gear which made harder work, and strange to say, prices becoming too cheap, etc. But after all the so-called decline was the temporary lull from an abnormal to a normal demand. There are more bicycles manufactured in France, and possibly England, than ever before, and American bicycle manufacturers tell me that notwithstanding the wealthier classes have retired from the field in favor of automobiles, the demand is steadily increasing and the business is again on a profitable basis.

From another point of view, there is no parallel between the uses of bicycles and automobiles, and there is no reason why the decline or fall of one should influence the other.

The bicycle is primarily more an article of pleasure and relaxation than a necessity. It was never supposed to usurp the functions of a horse—its radius to the average rider was much more limited, it was rather dirty and required too much exertion to remain permanently popular with the wealthier classes, most of whom owned horses, carriages, etc. I never heard of anyone discarding horses and relying principally upon bicycles for their method of transportation, while most automobilists are discarding horses.

In my opinion, the question should properly be: Will the demand for automobiles have a decided lull and a slow reaction the same as the bicycle?"

To a comparatively limited extent, I should say there will be within a few years a temporary and healthy lull in the demand for pleasure cars. At the present time, there are a large number of automobile manufacturers who have neither the capital, experience, facilities or volume of business to profitably succeed, and that element will necessarily and gradually withdraw. The beginning of the end of that kind of competition has already begun, for more than fifty small or prospective manufacturers. As a matter of fact the small manufacturer cannot now successfully compete in price and quality, for the large manufacturer now makes and ships the first two hundred or more cars without profit.

Since ancient times, the only method by which individuals were transported, was the horse, and the use of the horse, both for pleasure and business, had constantly increased for two thousand years up to within the past two or three years, when the decline of the horse for the transportation of individuals has noticeably decreased each year more and more.

Baron Rothschild predicted four years ago that within ten years the horse would not be seen on the streets of Paris. Even a better authority has predicted that within two years not a single horse-drawn cab will be seen on the streets of Paris. The streets of Paris to-day are full of automobile cabs that transport individuals cheaper and faster than horse cabs, and the most skeptical observer must admit, upon investigation, that the automobile within five years will entirely succeed the horse in everything except freight handling, and even that day seems not to be far off.

If it is a fact that for two thousand years the horse was practically the only method by which individuals were transported with scarcely, if any, improvement, since the days of the Roman chariot, the automobile, being the only successor, must be the only method until some better way is devised. This, at the present time, is not even dreamed of or predicted, and hence, I believe that for a thousand years, the automobile, especially when changed, perfected and improved to suit the growing needs, will be practically the only method by which individuals are transported beyond a walking radius, and the demand will increase and increase until the man afoot, beyond a short walking radius, will be a rarity. In fact, it may not be an idle dream to predict that within a century the practice of walking long distances will be discontinued and people will be unable to take long walks, but will use roller skates, bicycles, motor bicycles and automobiles. E. R. THOMAS.

Buffalo, N. Y.

From Ford Motor Co., Detroit, Mich.

You make the erroneous statement that there are less bicycles in use to-day than in the days when they were the craze. I think if you will take the trouble to look it up you will find that there were more bicycles manufactured last year than there were manufactured in any one year previously. The Geo. N. Pierce Company, of Buffalo, who rank as one of the most successful automobile concerns, will tell you that their bicycle business is still the more profitable industry, employs more men, and is altogether of greater magnitude than their automobile business.

True, there are not so many concerns manufacturing bicycles as there were; but this is due to the fact that the bicycle has to-day been reduced to absolutely standard form and is

manufactured in enormous quantities by automatic machinery. It was only when this state of perfection had been reached that there was over-production of bicycles.

You say, "In many towns the bicycle is rarely seen on the streets." If you take another look, you will see them in plenty. The difference is that we do not *notice* them now days. It is true that as a pleasure conveyance the bicycle has out-run the craze period, but only a few days ago we had to build a large addition to our bicycle shed to take care of the new machines of our employees. In other words, it is a utility vehicle.

You will remember that you saw more automobiles on the streets when there were only a score or so of them than you do to-day when there are thousands. They were a curiosity then, now they are as common as horses.

We agree with you that the "cross-country runs," to express in your own very admirable terms, "tearing through the country at railroad speed, going nowhere in particular, and seeing nothing as he goes," will soon come to an end. I think the majority of automobilists, while demanding high speed possibilities in their machines, really prefer to drive at a rational pace and enjoy the fresh air and scenery, rather than gulp down dust and leave dust behind them for others to swallow; and for genuine pleasure riding the touring car will stay, while for business purposes the runabout will take the place of the horse-drawn runabout almost exclusively. Then in the commercial field the possibilities are simply unlimited.

Concluding, the bicycle is not past but still remains the most useful mode of transportation for the individual that man's ingenuity ever devised. There is no relation between the automobile and the bicycle, except the pneumatic tires, any more than there is between the horse and the bicycle; and there is no more reason why the motor-propelled vehicle should ever become obsolete than there is that we should substitute ox teams for locomotives for cross-country transportation. E. LE ROY PELLETIER.

Detroit, Mich.

From Olds Motor Works, Lansing, Mich.

Notwithstanding the fact that people are constantly predicting that the automobile is a fad, and will soon go the way of the bicycle, yet such is not the case. One might almost as well say that steam cars or electric cars will be relegated to museums in the course of a few years.

Any one who has studied the subject of transportation knows that anything which is done to decrease the time required for conveying people or freight from one place to another is bound to succeed and should realize that the automobile will fill its niche and remain an important factor in the business world. Whether or not the strictly pleasure vehicle will survive is a question.

Many of the men who are now driving machines are well-known horse fanciers, and it will not be at all strange if they take up this sport again after they are tired of motoring. A large number of automobile enthusiasts are in a like position, and may lose interest, but it is hardly possible that they will give up their machines entirely, owing to the fact that the new form of transportation has already become a necessity of their daily lives.

From a business standpoint, however, the situation looks entirely different. The various produce men of the country have already installed a large number of trucks and other style of motor cars; telephone, telegraph and railroad companies are using them in connection with their traffic department, and nearly all of the large wholesale and retail dealers in the cities have, or are contemplating the purchase of some sort of horseless vehicle. With the coming of good roads and good pavements the cost of transportation by means of the motor car will decrease proportionately, and the time will soon come when automobiles will no longer be a luxury but an absolute necessity—one of the most valuable adjuncts of the commercial world. Nor is this true alone of the larger companies. Individual salesmen, real estate agents, and in fact every business man who is called upon to make frequent and sometimes lengthy trips about the city, find a machine such an easy means of getting from place to place, that they would as soon think of giving it up as of throwing their telephone out of the window.

No; there is no question but what the automobile has come to stay and we, as manufacturers, are putting forth every effort to put this business on a strictly standard basis, and produce a car which will not be in style one year and out of style the next, but a machine which will be practically comfortable and serviceable for years to come.

Lansing, Mich. FAY L. FAUROTE.

From Stevens-Duryea Co., Chicopee Falls, Mass.

This is a subject in which we have been very much interested for a number of years, and, consequently, have looked it up much more carefully than people who are not directly interested in a heavy, financial way. Studying the situation of recreation and sports for many years past, we cannot help but notice that those sports which require a large expenditure of work by the participants, sooner or later lose some of their stronghold and, in that way, become "back-numbers."

Now every sane person knows that the recreation which one gets from a limited amount of bicycle-riding, golf or tennis playing, is a grand good thing for the human system; but in all of these sports a large amount of personal effort must be expended by the player, and many times in the year when the weather is very warm and uncomfortable, one prefers to sit on the piazza or in the shade of a good tree, rather than to go out in the open and exercise, which, if used in a limited quantity, would certainly do more good than inaction.

We consider that the human race is naturally lazy and one wants to get through life as easily as possible and with as little expenditure of energy as he can; consequently, the sports which give the most recreation with the least exertion would be the ones to stay with the public.

We consider that the automobile and the motor boat (and possibly in the near future, the balloon) will cover that requisite. Now take the motor boat business as an illustration: We consider that to the water what the automobile is to the land; but as the motor boat business has been developed many more years than the automobile industry, we have some data to work on in connection with the latter.

One cannot travel anywhere on the water nowadays without being surprised at the large number of motor boats of all sorts, shapes and sizes which are found throughout the country. The motor boat business has increased by leaps and bounds for a number of years past, and no man would think, in these days, of taking a twenty-mile pleasure row to call on a friend in an evening, when he could sit in his motor boat and be landed there with no energy on his part and a very pleasant recreation for both himself and his friends.

What applies to the motor boat business we think will equally apply to the automobile business, and, while the present prices of automobiles are prohibitory to a large class of people, yet in the future development, simplification of parts and stability of styles, makers not being obliged to change their entire output from year to year, will naturally bring about changes in prices, the same as it has in the motor boat business. The motor cycle is another illustration of an article which is becoming very popular from the fact that a person is able to cover a very large amount of ground without very much effort on his part.

When the "denaturized alcohol" bill goes into effect, it may reduce the cost of running both of automobiles and motor boats considerably, and, as time goes on, other materials may be adopted to be used for fuel, and, in that way, reduce the cost.

But turning to the automobile truck situation: We feel absolutely positive that both the small and the large trucks will very largely supersede horse-power for moving the traffic of our towns and cities. It may take quite a little while to bring this about, but it is surely coming as certain as the sun rises every morning. We do not consider that it is more than a few years away when every small tradesman who makes delivery of goods or parcels will have his automobile carriage or truck for delivering the same, taking the place of his horse-drawn vehicle. J. H. PAGE.

Chicopee Falls, Mass.

* * *

One of the petty abuses to which the various express companies seem to be given is the deliberate losing of empty return packages for butter, eggs and other farm products. Finding that the return privilege means the annual handling of thousands of empty packages for which no direct return is obtained, the companies are apparently following the policy of side tracking such packages indefinitely and making the shippers stand the loss. It seems to be another example of the deliberate trampling on the rights of people who have to make use of the common carriers, and is one of the examples which tend to make people in general regard all transportation companies sourly and with suspicion. The abuse is one of considerable importance when we consider the enormous number of packages used annually for handling such products. With the present high price of lumber and the growing scarcity and consequent increase in price it becomes more and more imperative that economy in packages should be the rule. Years ago express companies made the concession of returning empty packages free in order to stimulate this class of shipments. The matter of negligence on the part of common carriers is held as not coming within the purview of the Interstate Commerce Committee, but seemingly it is an abuse which must be handled by a body more powerful than the private individual.

* * *

The coming exposition of safety devices mentioned in the October issue will be held at the American Museum of Natural History, New York, January 28 to February 9, 1907. The exposition will show safety devices for protecting the lives of workmen and of the general public; it will also have exhibits pertaining to industrial hygiene, care of the health, etc.

A EUROPEAN MACHINERY HOUSE.

In the attractive city of Cologne, founded more than a thousand years ago on the banks of the Rhine, the writer found the most complete establishment for selling machine tools in Europe or America; the center of a wonderful selling organization which covers a great part of Europe and is now reaching out for trade in the Orient. The foundation of the business of Alfred H. Schütte was laid twenty-six years ago, and with its branches now employs a staff of commercial men and engineers numbering about three hundred. The main offices and salesrooms at Cologne cover a floor space of 40,000 square feet, and including the branches at Brussels, Liege, Paris, Milan, Turin, Barcelona and Bilboa, the firm will have

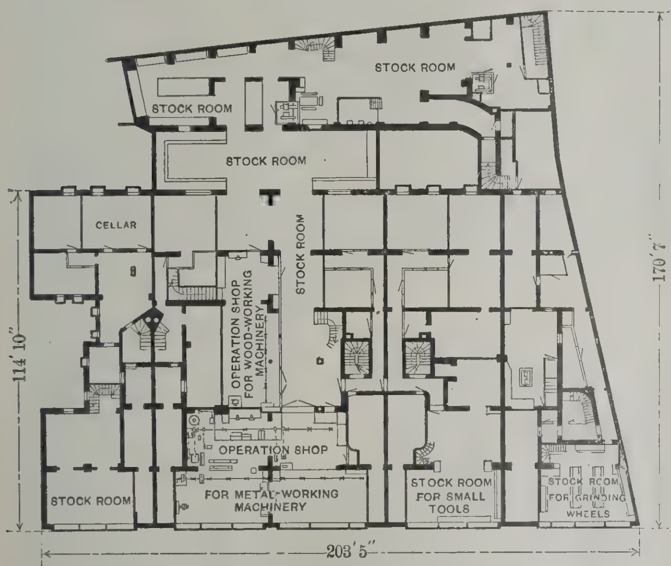


Fig. 1. Plan of Basement, Alfred H. Schutte's Machinery Store at Cologne, Germany.

a floor space of nearly 120,000 square feet after January 1st next, when the new stores under construction at Paris and Milan will be occupied.

The salesrooms at Cologne face one of the large squares in the center of the city, and have a row of show windows 205 feet in length in the handsome building which we illustrate, and which has been especially designed for the use of this firm. These windows permit not only a view of the salesrooms, but of a considerable part of the basement near the street, where metal and woodworking machines of the latest type are being operated under power, and where a plant of pneumatic tools is also shown in operation. The demonstration of machines in operation is found in nearly all of Mr. Schütte's stores and contributes largely to the success of the firm, because European engineers are more likely than our own to insist on seeing a machine in operation before purchasing. These facilities enable the firm to educate their staff of salesmen in the systematic manner characteristic of German methods, and they also contribute to the education of the young mechanical students of Cologne and vicinity.

The arrangement of the small tool department shown in one of the views is both attractive and convenient. Heavy oak is used for the wood work, and all the small tools, such as twist drills, reamers, etc., of which they carry a large stock, are placed behind sliding plate glass windows. One of the salesrooms is used exclusively for the exhibition of grinding wheels, and the writer saw there the largest stock that he had seen anywhere. The showrooms are situated on the ground floor and the operating rooms in the basement, which not only affords excellent light on the machines, but adds a touch of life to the building as the machines are seen in operation through the basement windows, a feature which is seldom found in a machinery salesroom. Facing the square are the private offices with bookkeeping and statistical departments. In the latter department each customer has an account showing the inquiries he made with the results of the offers submitted to him and his purchases, which affords an opportunity for calling the salesmen's attention to customers whose purchases have dropped off in any particular line.

An interesting feature is what might be termed the daily inventory. Every day a list is prepared showing a summarized statement of all the machines in stock in each of the stores of Alfred H. Schütte throughout Europe. At night all the machines sold during the day are checked off from this list and a new one prepared, a copy of which is furnished the next morning to every man who has anything to do with inquiries for machinery or tools. This list enables him to find at a glance whether a certain machine is in stock or not, without going into the stock rooms and referring in each particular case to the keeper of the stock. This feature of the system actually amounts to a daily inventory, but on account of the precision with which the records are kept there is very little delay or unnecessary work connected with the making up of these lists.

The department for correspondence, etc., is located in the rear, and its organization is very thorough and carried out in great detail. There are four different departments having charge of the sale of different kinds of machines and tools, each of which has special engineers at its disposal to push the selling end from both the mechanical and engineering points of view. Statements of sales are made up by every department at the week's end, and naturally each one tries to outdo the other in this friendly competition. In the department which handles automatic machinery is an unusually complete collection of sample pieces that have been made on full and half automatics sold by the firm, with full information regarding the cost of output, material, time required, etc.

One feature which indicates the extent to which the details of organization are carried is worth noting: Each Monday Mr. Schütte has on his desk a brief summary of every letter of importance that has been received or written by all of his houses throughout Europe and the answer thereto, as well as a complete statement of all machines and tools sold and in stock in each branch house during the previous week. These are arranged in the form of a list, and if Mr. Schütte for any reason, desires to follow up the details further he simply marks with a blue pencil the specific letters

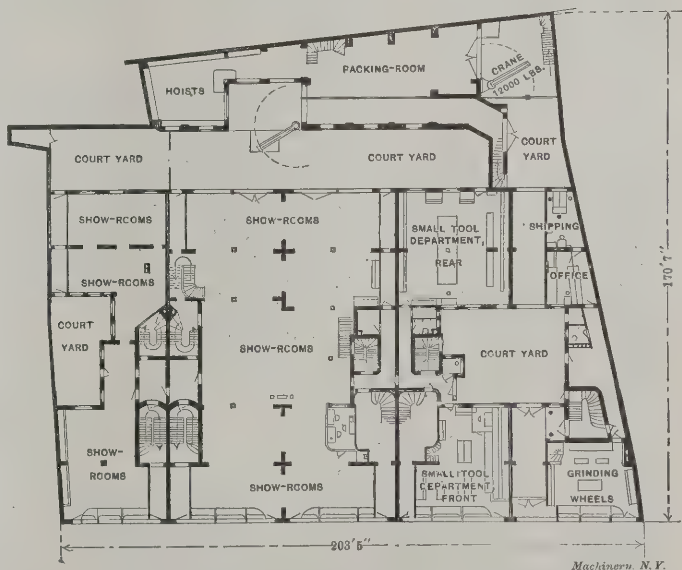


Fig. 2. Plan of Ground Floor, Alfred H. Schutte's Machinery Store at Cologne, Germany.

he desires, and complete copies are brought to him. All that portion of Europe covered by the Schütte organization is regularly visited by a large staff of salesmen reporting to the headquarters for each territory. In this way the entire territory is covered, not only by salesmen, but by specialists connected with important manufacturers whose product the firm sells. The catalogue and advertising work is in charge of engineers with practical experience in those lines.

Separated from the main office, but adjoining Mr. Schütte's private office are the offices of the newly established Asiatic and South American export department, in charge of Mr. T. H. Marburg, who until recently was manager of the New York office, and at the time of the writer's visit was preparing for a trip around the world to cover two years, for the

1. Special Tool Department for Automatic Screw Machines.
2. Testing Room for Woodworking Machinery.
3. View from Street of Alfred H. Schutte's Machinery Store, Cologne, Germany.
4. Testing Room for Automatic Machinery.
5. Main Machinery Hall, Right Aisle.
6. Small Tool Department, Front.
7. Grinding Wheel Store, seen from the Left.
8. Grinding Machine Store.
9. Main Machinery Hall, Left Aisle.

purpose of forming new connections and cultivating existing ones.

The organization of the different branches is carried along on similar lines, and a short description of these will doubtless be of interest.

In the small but wealthy industrial country of Belgium the firm employs a staff of thirty-four men. In 1897 a branch was started at Brussels under the management of Mr. A. Ispert, who is a junior partner of the Belgium firm. The gradual increase of business soon made it necessary to abandon the original quarters for larger ones at 5 Vieux-Marche-aux-Grains. In 1903 a sub-branch was established at Liege, the center of the Belgium arms manufacture, and in this branch the firm is doing a good business in small tools. A demonstration room has recently been erected in the rear of the Brussels store in order to improve the existing facilities for showing tools in operation, and including this new addition the firm has now over 12,000 square feet of floor space in the busiest parts of Brussels and Liege at its disposal.

The French establishment of the firm was organized in August, 1903, under the management of Mr. Max Bühling, and although only entering its fourth year is one of the largest dealers in American machine tools in France. The present offices are located near the center of Paris, but owing to the development of business a new building specially adapted to machine tools is now under construction and will be finished by the end of the year. This store will be about four times the size of the present one, covering a floor space of about

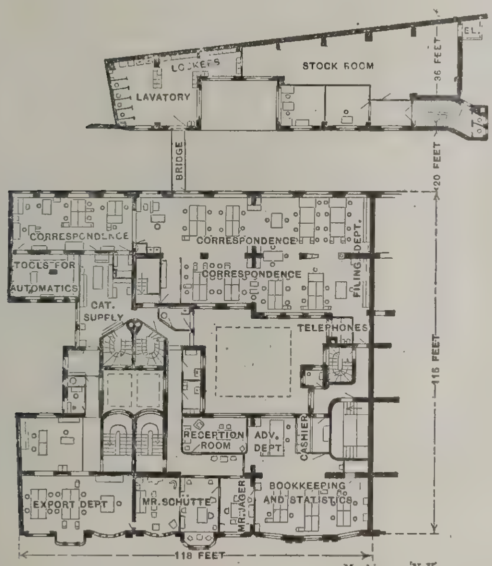


Fig. 3. Plan of Second Floor, Alfred H. Schutte's Machinery Store at Cologne, Germany.

25,000 square feet and will be provided with traveling cranes, etc. The demonstration rooms will be divided into two distinct parts, one for metal-working and the other for woodworking machines, electrically driven by two 30 horsepower motors. The general arrangement of the small tool department at the new store will be similar to the one in the Cologne establishment. The diversity of nationalities found in all of the Schütte houses is most pronounced in Paris, where a staff of forty, composed mainly of Frenchmen and Germans, with some Americans and Englishmen, seems to work in perfect harmony.

The Italian branch was established in Milan in April, 1903, under the management of Mr. H. Wingen, who had previously worked up a connection among the leading Italian manufacturers, notably those in the motor car industry, which has since then developed with great rapidity. The Milan branch was started with twelve employees, but during the past three and a half years the business has increased to such an extent that a force of about sixty is now employed, and a store established at Turin to further facilitate the distribution of goods, as well as a branch office at Genoa to handle machinery arriving from America. New quarters somewhat similar to those in Paris are under construction, which will give the Milan branch a floor space of about 25,000 square feet after January 1, 1907.

Business in Spain has been pushed by the firm for many years, but not until 1903 was a store opened at Bilboa and put in charge of Mr. Max Daunert, formerly manager of the New York office. The machinery industries are developing slowly in Spain, manufacturers there not taking as readily to the better class of tools as in other European countries. Notwithstanding these conditions and the general depression which has prevailed in Spain for the last two years, the firm has started a second store, also under Mr. Daunert's management at Barcelona, and the prospects are good for satisfactory business.

At New York the firm maintains an office in the Havemeyer Building, 26 Cortlandt Street, Mr. F. W. Jaeger, manager, which keeps in close touch with the machinery trade in this country and cares for the shipments to the different branches.

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ANNUAL MEETING OF THE A. S. M. E.

The annual meeting of the American Society of Mechanical Engineers will be held in the auditorium of the New York Edison Co., 44 West 27th Street, beginning December 4, and continuing through December 7. Following are the papers:

President's address by Mr. Fred. W. Taylor, Philadelphia, Pa.: "The Art of Cutting Metals."

Report of the Committee on Standard Proportions for Machine Screws.

"The Evolution of Gas Power," by Mr. F. E. Junge, Berlin, Germany.

"Producer Gas Power Plant," by Mr. J. R. Bibbins, Pittsburg, Pa.

"Steam Turbine Characteristics," by Mr. Hans Holzwarth, Hamilton, Ohio.

"A High Duty Air Compressor," by Prof. O. P. Hood, Houghton, Mich.

"Design of an Improved Boiler Setting," by Mr. A. Bement, Chicago, Ill.

"The Steam Plant of the White Motor Car," by Prof. R. C. Carpenter, Ithaca, N. Y.

"Saw-Tooth Roof Construction," by Mr. F. S. Hinds, Boston, Mass.

"Ferroinclave Roof Construction" by Mr. A. E. Brown, Cleveland, Ohio.

"Saw-Tooth Roofs for Factories," by Mr. K. C. Richmond, Providence, R. I.

"Weights and Measures," by Mr. Henry R. Towne, New York.

"Mechanical Engineering Index," by Prof. W. W. Bird and Prof. A. L. Smith, Worcester, Mass.

"Ventilation of Boston Subway," by Mr. H. A. Carson, Boston, Mass.

"Flow of Fluids in Venturi Tubes," by Mr. E. P. Coleman, Buffalo, N. Y.

"Tests of an Elevator Plant," by Mr. A. J. Herschmann, New York.

"Test of a Rotary Pump," by Prof. W. B. Gregory, New Orleans, La.

"Improved Transmission Dynamometer," by Mr. W. F. Durand, Stanford University, Cal.

"A Plan to Provide Skilled Workmen," by Mr. M. W. Alexander, Lynn, Mass.

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The ease with which some inventors are able to induce people of sufficient capital to believe in the possibilities of their inventions has often been referred to. However, our English brethren seem in this respect to excel our own inventors. An English gentleman who lately attended the London Bankruptcy Court and whose liabilities amounted to $75,000, compared with $7,500 assets, stated that his financial difficulties were due to his connection with an inventor who invited him to join in a hydroscope scheme. The hydroscope, he informed the court, was an instrument for searching under the sea for sunken treasures and he was to be reimbursed either from the treasure when discovered, or out of the proceeds to be derived from the sale of the patent to an exploiting company. It is at least to the credit of our English contemporaries that the forming of such a company did not seem to be within the possibilities of the able inventor. We find occasion to recall the incident of the American company which a few years ago was to proceed to procure gold out of sea water.

WILLIAM KENT.

REPRESENTATIVE AMERICAN MECHANICS AND ENGINEERS.

William Kent was born in Philadelphia, March 5, 1851. He was educated in the public schools and graduated from the Central High School of Philadelphia in 1868 with the degree of A.B. The degree of A.M. was conferred in 1873. He was clerk and bookkeeper in a coal shipping house for nearly two years and then was bookkeeper in the Jersey City gas office two and a half years. While there he attended night school in Cooper Union, New York, and graduated with the class of 1872. After graduation he obtained the position of bookkeeper in the Ringwood Iron Works, at Hewitt, N. J., where he had an opportunity to get some practice in engineering and chemistry. The depression in the iron trade following the panic of 1873 caused the shutting down of the blast furnace, and he left at the end of 1874 to enter Stevens Institute of Technology as special student. In June, 1875, he was appointed assistant to Prof. R. H. Thurston in the work of the United States Iron and Steel Testing Board, and under his direction carried on for two years a research on the properties of the alloys of copper and tin, and copper and zinc. He also qualified as regular student in the senior class and graduated in 1876 with the degree of M.E.

In 1877, on the conclusion of the research, he went to Pittsburg to take a position as draftsman with a firm of blast furnace engineers. While in that position he made a trip through the new iron district in the Hocking Valley, Ohio, and wrote an account of the district for the *American Manufacturer* of Pittsburg. This led to his appointment as editor of that paper, which position he held for two years. In the next three years he was engaged in the iron and steel works of Shoenberger & Co., first as general assistant, and later as superintendent of the open hearth steel department. A severe attack of typhoid fever followed by a nervous breakdown led to his resigning his position in 1882 and going to Europe for three months for his health. On his return he opened an office in Pittsburg for the Babcock & Wilcox Co., and introduced that company's boilers in Western Pennsylvania and Eastern Ohio. He also formed a partnership with William F. Zimmerman in the organization of the Pittsburg Testing Laboratory, which was sold three years later to Messrs. Hunt and Clapp. In 1883 he was transferred to the New York office of the Babcock & Wilcox Co. as superintendent of the sales department and engineer of tests. He resigned in 1885 to become the general manager of the Springer Torsion Balance Co. He developed the invention of the balance (a weighing scale with torsional pivots instead of knife edges, used generally in the retail drug trade), and built and equipped a factory in Jersey City for its manufacture. This work occupied him until 1890, when he opened an office in New York as consulting engineer.

For the next thirteen years his work was of the most varied character, including engineering design and construction, engine and boiler testing, expert work in the courts, and literary work. In 1891 he began work on his "Mechanical Engineer's Pocket-Book," which took four years to complete. The book was published in 1895 and immediately was recognized as filling a long-felt want among engineers, draftsmen, machinists and others having to do with mechanical work and design. More than 45,000 copies have been sold at the present time and the sales are increasing from year to year. Prof. Kent is an ardent opponent of the metric system and in speaking against it before the House Coinage Committee of Congress in 1903 he used his experience in the compilation of the pocketbook against the adoption of the metric system in the following effective language (see MACHINERY, May, 1904):

"In 1895 I published a mechanical engineer's pocketbook, of which more than 30,000 copies have been sold. The collection of material for this pocketbook took more or less of my time for twenty years, and the making of the book not less than three years' full time. The things compiled in it involved reference to engineering works, papers and periodicals, some of them dating back at least sixty years. There are 1,100 pages in the book, and each page has about 900 words. The number of figures and formulas in the book, which are based on the English inch, run into more thousands than I would care to figure. The task of getting such a book free from errors is a tremendous one. Over a thousand typographical and other errors have been reported in the last eight years. Mr. John C. Trautwine, Jr., told me some twenty years after his father's civil engineers' pocketbook was first published that he was only then beginning to feel that the book was reasonably free from errors. If my book were translated into the metric system, it would be at least ten years before all the errors in the translation would be rectified. I doubt if the translation could be made without at least five years' hard labor of an expert mathematician."

In 1898 and 1901 he obtained patents on the "Wingwall" smokeless furnace for steam boilers, which is now being introduced in the West by his agents, Power Specialty Co., New York and Chicago. He also patented in 1903 a gas producer for use in connection with gas engines. It involves the principle of getting rid of the tar in the gas by burning all the hydrocarbons in the producer itself by means of air drawn in at the top of the producer. In 1901 he brought out his treatise on "Steam Boiler Economy." In 1895 he became one of the associate editors of *Engineering News*, holding the position until 1903, but in the last four years of that time did only occasional editorial work, on account of the pressure of other work. In 1903 he accepted the position of Dean and Professor of Mechanical Engineering in the L. C. Smith College of Applied Science in Syracuse University, which position he still holds. In 1905 the university conferred on him the degree of Doctor of Science.

Prof. Kent has been a member of the American Institute of Mining Engineers since 1876, and of the American Society of Mechanical Engineers since its organization in 1880. He has been vice-president of that society and last year he was president of the American Society of Heating and Ventilating Engineers and of the Technology Club of Syracuse, N. Y.

* * *

Two large chimneys of reinforced concrete are at present being built in England, one with a diameter of 20 feet and a height of 265 feet, and one with a diameter of only 8 feet 6 inches and a height of 245 feet. In this country there are also a few chimneys of similar proportions being built out of reinforced concrete. There are ample indications that concrete is going to replace brick in a large measure in the future, particularly with present high prices of brick. Certain kinds of brick have doubled in price during the last decade.

* * *

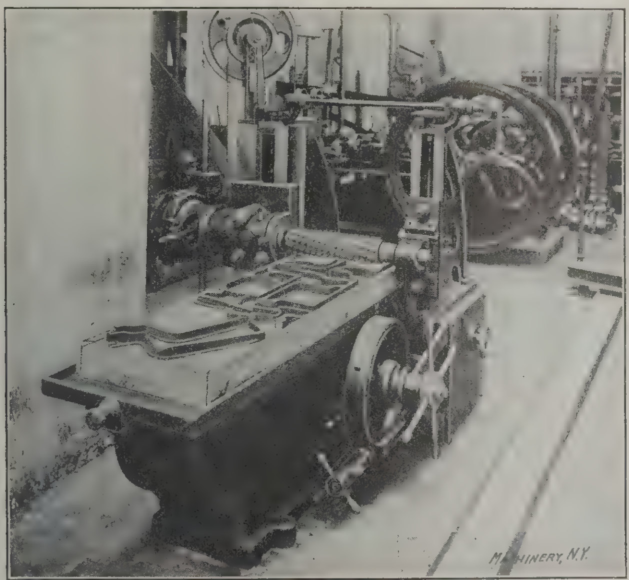
The possibilities which will present themselves in many fields where denatured alcohol can be used are fairly indicated by the low price at which it can be sold when produced on a sufficiently large scale. The present wholesale prices in Germany, where more than 25,000,000 gallons are consumed in a year, are at present 25 to 26 cents a gallon, and the retail prices vary from 27 to 30 cents a gallon.

LETTERS UPON PRACTICAL SUBJECTS.

HOLDING THIN IRREGULAR CASTINGS TO THE PLANER TABLE.

We have seen in your September issue an article "Planing a Small Machine Part." The examples given are very good indeed, but we think that we have something fully as interesting on the same line to put before your readers. The chucks and jigs shown in the article are very expensive; they take up considerable space and in our opinion they do not quite fill the purpose, especially when the castings are very thin. The accompanying halftone shows how we hold thin, irregular castings on the table of the planer or the milling machine. The idea has been carried out by our works manager, Monsieur Tête, and is a development in the manufacture of our pattern plates.

The illustration shows a number of irregular-shaped castings on the table of an Ingersoll milling machine, which we have in our works. When the castings are in place, four boards or planks are put on the four sides of the table and a few pieces of wood in the table holes. Then plaster-of-paris is poured around the castings and allowed to set for a few minutes. By this means the pieces are not only clamped but supported underneath the whole surface, and thus have no



Holding Thin Irregular Castings to the Planer Table.

tendency to spring under the pressure of the cutter. This method when first tried proved a success and since this time all work of a similar character is made in the same way in our works. The method saves a lot of time and is a real economy in the cost of production. We believe that the idea can be extended a great deal and that it will be of benefit to some of your readers. Plaster-of-paris is very cheap and sets in a few minutes. The only drawback to its use is that the table of the machine gets dirty after the plaster has been broken into pieces. PH. BONVILLAIN AND E. RONCERAY.

Paris, France.

FINISHING VALVE SEATS AND CYLINDERS.

There are probably more differences of opinion regarding the proper way to finish valve seats for slide valves in locomotives and boring cylinders than in regard to almost any other parts of the whole locomotive. In most cases the valve seats are planed and scraped and the valves treated in the same way. Scraping seats to a bearing means a lot of work, and unless it is done by a good man it is apt to be worse than when it came off the planer.

Wilson Eddy, whose genius presided over the old Worcester and Springfield road in the late fifties and sixties, and who was a wonderfully sensible railroad man in many ways, used a false valve seat of cast iron about as shown in Fig. 1, and held the whole thing down by the steam chest cover, which was bolted on the outside, as shown by the stud holes. The false seat was more necessary in the days before the portable planer than now, and it was not of this as much as of his way of finishing that I intended to speak. The valve was clamped to the planer with as little strain as possible, to avoid spring when released, and after the roughing cut (if a new valve), the finishing cut was made with a sharp pointed V tool with a fine feed, so as to make a series of fine grooves along the face of valve. The seat was planed in the same way, but with the grooves running the other way, and they

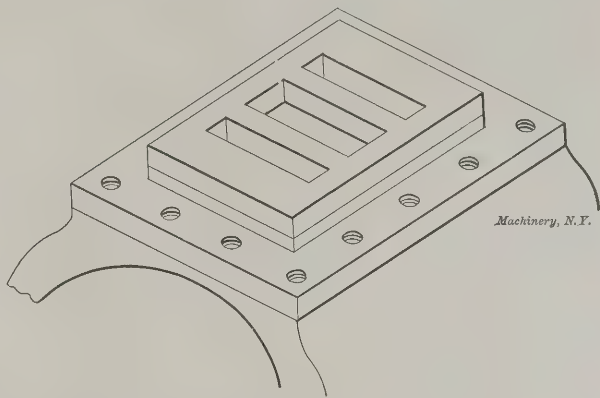


Fig. 1. False Valve Seat for Locomotive Slide Valves.

went into service without having a scraper touching the seat or valve. The grooves held the oil until the tool marks wore out, which happened in a comparatively few miles and the valves never cut. They wore down to a bearing, and made a first-class job in every way. Even with the seats planed by a rotary planer as at present, there should be no trouble about using valves planed in this way and it would at least be worth a trial. Fig. 2 gives an exaggerated idea of the tool marks left on the face of the valve; those in the seat run the other way.

Cylinder boring is another question that is open to discussion. It used to be considered a crime to stop a lathe or boring mill on a cylinder cut until it was through, and some places even go so far as to use emery in the cylinder to polish them and get out the tool marks. I believe the emery is bad in any case and I also question the advisability of trying to get such a smooth cylinder. One of the best engineers I know of, one who has charge of large steam plants and is responsible for their economical performance, never allows a finishing cut to be taken in the cylinders of his engines, either when making them new or when reboring. He prefers to have them just as they come from the roughing tool. They soon wear down to a good bearing, the piston travels too fast to have any leakage past the rings around the bore of the cylinder, and he can always depend on what a cylinder will do in the way of tending to business and not get to cutting. Last but not least, it saves the cost of the finishing cut as well as the time it keeps a locomotive out of service, and this time is quite an item when slowly-working portable boring bars are used so as to facilitate the work. Whether you try the plans or not they are worth thinking over.

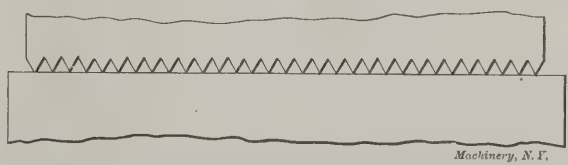


Fig. 2. Exaggerated Appearance of Valve Face.

I. B. RICH.

JACK MAKES A FORMULA.

We were making some rings at our shop, of a section shown in Fig. 1. The fillet was made up of two curves; one had a short radius s and was $\frac{3}{8}$ inch long, while the other radius R had its center $1\frac{1}{2}$ inch from the vertical side, but the length of R was figured out so that we should have a smooth curve

when the two arcs met. Of course the fillet was a tangent to the vertical and horizontal sides.

There were several sizes of rings and we were to make templets for them; so while I was making the first drawing our apprentice, who is just now having a show at drawing, took a sketch of the ring and fillet, and tried to hitch up his correspondence school mathematics to the job of pulling out a formula to give the exact length of R. Jack had to have a little help to get started and then it was just like other algebra examples in his book.

His sketch is shown in Fig. 2, and all the dimensions are letters instead of figures:

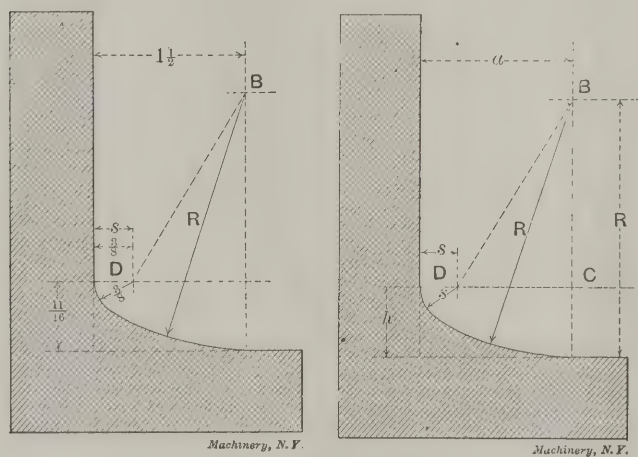
a = distance from vertical wall to center B.
s = distance from vertical wall to center D.
h = distance up from horizontal wall to center D.
R = distance up from horizontal wall to center B.

We know all of these distances except R (see Fig. 2), and if we can make up an equation using these distances we can solve the equation and find the length of R.

Suppose we let R swing up to the line $B\,D$ and at the same time let s swing down till its arc meets the arc made by R. These curves will meet and make a smooth curve for the fillet. Jack says he can prove that by geometry. There is a triangle, $B\,C\,D$ in Fig. 2, with a right angle at C, and we can make up an equation by the aid of this right-angled triangle.

The side $B\,C$ is equal to $R - h$;
The side $C\,D$ is equal to $a - s$;
The side $D\,B$ is equal to $R - s$,

because R and s make a straight line from B through D to the fillet. Now, in every triangle like $B\,C\,D$ the square of the side opposite the right angle is equal to the sum of the squares of the other two sides. Hence Jack wrote his equation as follows:



Figs. 1 and 2. Jack Makes a Formula.

$$(R - s)^2 = (a - s)^2 + (R - h)^2$$

and solved for R as below:

$$R^2 - 2\,R\,s + s^2 = a^2 - 2\,a\,s + s^2 + R^2 - 2\,R\,h + h^2$$
$$R^2 - R^2 + s^2 - s^2 - 2\,R\,s + 2\,R\,h = h^2 + a^2 - 2\,a\,s$$
$$R\,(2\,h - 2\,s) = h^2 + a^2 - 2\,a\,s$$
$$R = \frac{h^2 + a^2 - 2\,a\,s}{2\,h - 2\,s}$$
$$R = \frac{h^2 + (a - 2\,s)\,a}{2\,(h - s)}$$

Jack substituted the dimensions given in Fig. 1 ($a = 1\frac{1}{2}$, or 1.5 inch; h = 11-16, or 0.687 inch; $s = \frac{3}{8}$, or 0.375 inch) in the formula and multiplied, added, etc., as the signs in the formula direct.

$$R = \frac{0.687^2 + (1.5 - 0.75)\,1.5}{2\,(0.687 - 0.375)}$$
$$R = \frac{0.472 + 1.125}{0.624}$$
$$R = \frac{1.597}{0.624} = 2.559, \text{ or } 2\ 9\text{-}16 \text{ inches, very nearly.}$$

Then I set my compasses to Jack's figures and finished the fillet. It was all right. The templet maker has not yet found any trouble with the radius, and Jack is sure the radius R is all right.

If the boys in the shop would try to figure out some problems that come up there, they would get the knack of applying their mathematics to "cold iron." The above has been written to help young men like Jack to use some of the mathematics they have studied.

JACK'S FRIEND.

THE BORING BAR VS. THE FORGED BORING TOOL.

There is scarcely any machine shop operation more tedious and unsatisfactory than that of boring a *long* hole, which is required to be *quite parallel*, with a common forged boring tool. In the best manufacturing shops, suitable drills and reamers are provided for each job, and standard sizes are

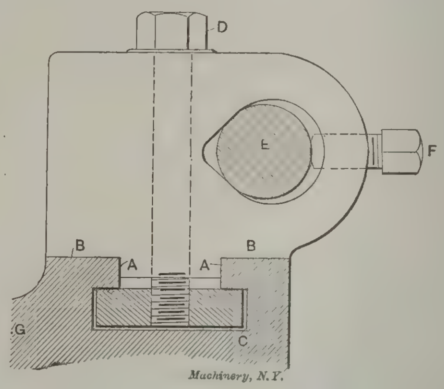


Fig. 1. Boring Tool Holder.

generally used. But in the repair shop and job shop the conditions are quite different. In the very nature of the case such shops cannot have tools exactly suited to every unexpected and nondescriptive job which may be presented. However, some job shops make very little effort to keep up with the times, and their equipment is too much of the scrap-heap order. The writer at this time has in mind one of these back-number institutions. A short time ago Mr. A. brought to the shop in question a job of boring which was wanted in a hurry. Well, he did not get it in a hurry; and when the bill was presented the charges were so much beyond what Mr. A. had expected that he consulted the writer as to how it was possible to put in so much time on the work. The latter consisted in enlarging the bore of a device which was sold on a very small margin. When the job shop got the work done there was no margin at all. Now, there had apparently been no dishonesty as to the time charged. It was difficult to true up the work in the "rickety" old chuck, and it took a long

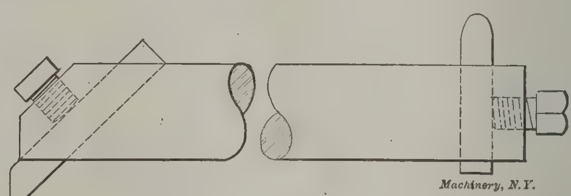


Fig. 2. Boring Bar with Cutters Inserted.

time to bore it, because the only long tool available was by far too slender and "springy." Mr. A paid the bill, but declared he would never take another job to that shop. The job shop man presumably means to be honest, but the writer fails to see how one can be strictly conscientious who *regularly* uses time-wasting tools and charges the full price for the time so wasted. However, the job shop proprietor did not see the matter in that light.

There have been various designs of boring tool holders described in the mechanical papers. The best of these require a different bushing for each size of bar; but such as have been made by the writer need no bushings. Fig. 1 shows an end view of a device which costs very little to make, and which works very well. This was designed for a young machinist who has a small shop with no other machine tools than a lathe

and a drill press; and he wanted to avoid the expense of having his casting planed, or of milling it at a disadvantage in his lathe. Under these circumstances the pattern, which was in one piece without core prints, was made so close to size that it required but a few minutes chipping and filing on the sides *A* of the tongue, and on the flats *B*, to make the casting fit the slot of the tool rest *G*. The part *C* in the sketch was simply a piece of flat bar stock equal in length to the slot, and tapped for two screws *D*. The bar, a section of which is shown at *E*, is held by two setscrews *F* as indicated. As to the construction of the bars, these were also made, or at least could have been made, with small expense. While a turned tool steel bar might be desirable, simple cold-rolled steel, or rough machine steel will answer fairly well. The cutters may be round bar steel (no turning is needed) held in a drilled hole by set screws. Fig. 2 shows such a bar with a cutter at each end. Three or four different sizes of these bars will answer for a wide range of work. Now, is there any excuse for the job shop being without such an outfit as this? In the long run, far more time is wasted in using inefficient boring tools, and in redressing old ones, than would be required to make the tools here described.

Having tools somewhat similar to the foregoing, the writer once wanted to bore a hole which was too long for any bar on hand. It was a simple matter to select from the stock of steel the shortest piece of the right diameter, and drill it for cutters and set screws. This was accomplished in less time than would have been required to forge a new tool. As the bar was only about three feet long it was retained for emergencies; but obviously it could have been cut up and used for any other purpose. This case suggests the expediency of making the bars amply long in the first place. A long bar does not need to project from the clamping fixture any further than necessary for the job on hand. Not so with the old-fashioned boring tool. If that be made extra long it cannot advantageously be used with shorter projection.

One of the strongest points in favor of the boring tools here advocated is yet to be discussed. This feature can best be described by referring again to the foregoing example in which the long bar was employed. In this case a long parallel hole of a size different from any available reamer was wanted. Having rough bored the hole to within about 1-64 inch of the final diameter, a double-pointed cutter was made from bar stock. With this, one cut was taken through the hole, when it was found to be entirely satisfactory. It will be understood that the advantage of the double-ended cutter lies in the support that one point furnishes for the opposite cutting point. This bracing effect tends toward parallelism of the cut, and such an arrangement may take the place of a reamer in emergencies. To get the best results with a double cutter, its ends should be turned in the lathe while the cutter is secured in its bar. For this purpose one end of the bar may be held in a chuck, the other end being supported in a steady-rest placed near the cutter. After being turned, the cutter is, of course, backed off and tempered. In this connection it should be remembered that a minimum of clearance should be filed on the heel of the cutter, otherwise chattering will result. The apparatus described (cutters excepted) may be used for polishing a bored hole, or for slightly enlarging it at any point where the gage may fit a little too snugly. For this work secure a short leather sleeve around the bar at one end, and glue emery cloth to the leather. The bar while clamped in the fixture may be fed through the hole by the regular carriage feed mechanism. Slightly revolving the bar will give new contact of the emery cloth.

The machinist for whom the fixture shown in Fig. 1 was designed requested the writer to show him how to make a rig for grinding in the lathe. For this purpose a cylindrical piece of cast iron was drilled lengthwise and babbitted to fit a small emery-wheel spindle. The cast iron was then turned on the outside to slip in the boring fixture; and thus the latter was used both for holding boring bars and for holding the bearing for the emery-wheel spindle. This rig, which was driven from an overhead drum, answered for grinding the 60-degree centers (the compound rest being swiveled for this) as well as for parallel shafts.

W. S. LEONARD.

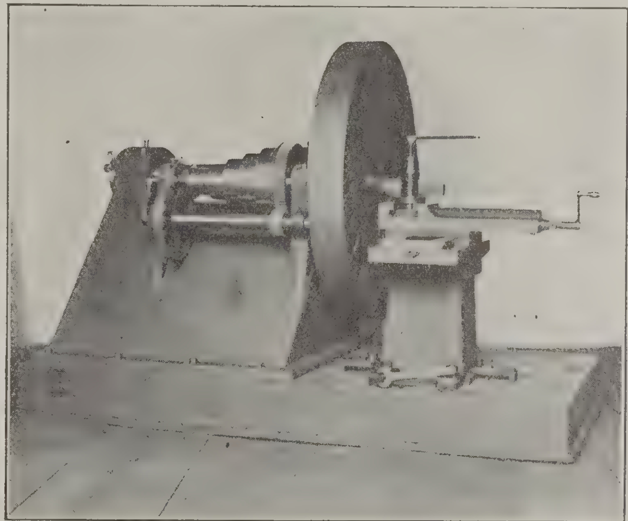
Lansing, Mich.

FACING LATHE OF UNUSUAL DESIGN.

The accompanying cut shows a machine, only one of which has ever been built so far as the writer knows, but the principle of which could be used for many special needs. It was built for work of from, say, 20 inches to 60 inches diameter to be fastened to the faceplate. It has feeds in all directions by means of an overhead rocking shaft, not shown. A hook will be noticed at the left-hand end of the spindle. This swivels on a bolt which can be moved across the spindle on a plate on the end of the spindle with a T-slot. To this hook is attached a chain which leads to one arm of the overhead rocking shaft and gives it a greater or less motion, according to the distance of the hook from the center line of the spindle. Near the other end of the rocking shaft is an adjustable arm which carries a chain which leads to a ratchet wrench which could be put either on the cross feed or the longitudinal feed-screw. With two holes in the ratchet lever, and the adjustment on the end of the spindle any feed from one tooth to five, or a range of from 0.02 inch to 0.1 inch could be obtained.

The way in which we happened to get the order for this machine was rather odd. One day an inquiry came from one of the numerous export agents in New York for a facing lathe to swing 50 inches, bid to be accompanied by drawings.

This inquiry came from a house which, so far as we knew, did not make a specialty of machine tools, and from such houses freak inquiries are common. I wrote and quoted on



Facing Lathe of Unusual Design.

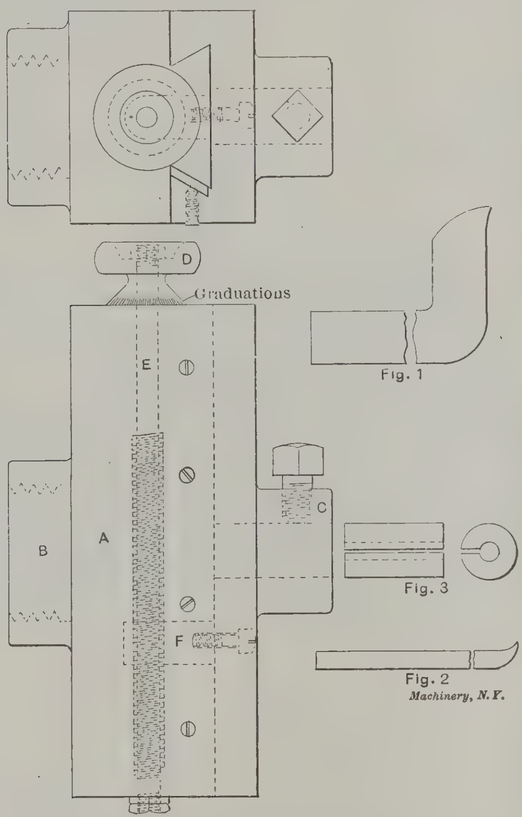
a full lathe with short bed. We received a letter back saying that price was what counted, and that only certain requirements were to be met, and asking for a revision of the bid. The idea came to me that we could build such a machine as shown in the cut. Consequently I made a bond-paper drawing fairly well to scale, but with only the principal dimensions of the bed and headstocks, and by that time I was tired of the job. I had not the slightest suspicion that an order would result, so I cut out a picture of a tool rest for a locomotive tire turning lathe from a catalogue and pinned it to a blueprint of the bed and head, added a hundred dollars to what I thought would be a fair price, and sent in the bid without a further thought. Three or four months later I was astounded to get an order as "per blueprint and specifications" for one of these machines to go to Vladivostock, Siberia. I chased up the drawing which I found I had used to scribble on, cleaned it up, put on a few more dimensions, and started in to see how we could get out of making a full set of patterns. We made a frame for the base with the molding around the bottom and let the foundry strike off the inside. Then we took core boxes that were used to take out the inside of a radial drill base and spliced up the sides two inches to fit. These cores hung over the edges of the drag and formed core and cope as well. The head itself was hastily framed up of ⅞-inch material to form its own core. The boxes for the main spindle were cast for babbitt. The bearings in front were set up for an 18-inch head cone and back gears. The spindle was of cast iron, 9 inches diameter front bearing. To

the spindle was keyed a 36-inch lathe faceplate with internal gear, but the faceplate was made 50 inches in diameter by casting on a false rim. This was swept up in the sand, and tightened by overhanging cores which framed both core and cope again. The spindle which ran through the cone pulley carried a driving pinion of steel to mesh with a cut internal gear on the faceplate. The tool rest demanded all new patterns except the top slide, which we took from a 36-inch lathe. The machine when ready proved to be just about what was wanted. It "growled" a good deal on high speeds, but on the size work called for it ran quiet enough. Except for the ratchet feed seeming a little crude, it was the equal, for work within its range, of the lathe on which we first quoted at a price three times as high, but with less than twice the profit in it for us. E. H. Fish.

Worcester, Mass.

BORING TOOL-HOLDER FOR MILLING MACHINE OR LATHE.

The sketch shows a fixture to be screwed onto the spindle of a milling machine or lathe for boring holes in work fastened to the milling machine table or to the carriage or cross-slide of a lathe. For boring holes in jigs and fixtures where the holes have to be exactly certain distances apart, either



Adjustable Boring Tool-holder.

in a vertical or horizontal plane, the fixture, if used on the milling machine, is a very serviceable tool. The fixture is screwed onto the machine spindle at *B* and when a tool is clamped in the tool-holder, *C*, the fixture is ready for use.

The knurled knob *D* turns the screw *E*, which works in the nut *F*, and causes the tool to move to bore a hole larger, or to be drawn back for a smaller hole.

In case of wanting to use the fixture on a machine which has a different thread on the spindle than the fixture, a taper plug can be made which fits the taper hole in the spindle and is threaded on the other end to fit the thread in the fixture. This particular fixture can be used for holes from ¼ inch diameter up to 6 or 8 inches diameter and 6 or 8 inches deep. For large holes, the tool is made of stock the size of the hole in *C*, and for small holes the tool can be made of smaller stock, and a split bushing made to fit the hole in *C* on the outside diameter, and the hole in the bushing to fit the tool. For large holes, the tool should be bent to a right angle, so that the tool-holder *C* will not have to be adjusted too far out. The adjusting knob *D* should be graduated in thousandths inch as shown in the sketch to provide for accurate adjustment of the tool. The fixture is fitted with gib and screws for the tool slide.

To get holes bored accurately certain distances apart in the milling machine, the holes are first drilled with a smaller sized drill than the finished size, and then the boring tool is used in the fixture, feeding the table along according to the graduated collar on the feed screw. The holes can then be bored very accurately. The roughing drill can be held in a split bushing, fitting the hole in the fixture. This fixture is used in the tool department of the Cadillac Motor Car Co.

Referring to the sketch, Fig. 1 is a heavy tool for large holes, Fig. 2 is a tool for small holes, and Fig. 3 is the bushing for the small tool. C. J. S.

TIME SAVING IN THE DRAFTING ROOM.

Under this heading in the August issue of Machinery Mr. F. R. Steuart recommends for quick duplicating of sketches a tracing in soft lead pencil. I believe my method is better than his, as it does away with any kind of tracing, pen or pencil, for sketches or for drawings. I have made short cuts and labor-saving dodges a close study for years, for the draftsman's work often comes in on the feast-or-famine plan, and there are times when a great volume of work must be rushed through quickly and accurately, though not necessarily with much neatness or finish. With the exception of drawings that must be repeatedly and frequently blueprinted, I make no tracings. Such as I make are made largely for the reason that they blueprint more rapidly and wear better. If the original drawing were used to blueprint from too often it would soon become worn out and unfit to make another copy from without much labor. So, for standard erecting plans, etc., I make tracings on cloth and keep the original carefully, though in the course of years it is likely to need alterations.

I use a smooth and semi-transparent drawing paper from which I can get a first-class blueprint in about two and one-fourth times the number of minutes required for tracing on cloth. The drawing is laid out in pencil, then the useless lines wiped off with a piece of "artgum," which is about halfway between stale bread and velvet rubber in its cleansing properties. It leaves the surface in good shape for inking, and when the drawing is inked it is done. There is no tracing to be made.

For sketching, I have two methods of duplicating, and which one is used depends generally upon the number of duplicates required. In case but one or two are needed, I make the sketch on fairly heavy cross-section paper with "Mephisto" colored copying pencils. The original sketch goes into the shop in this case, after being copied in an ordinary letter book with moistened pads. A second copy can be made on a loose sheet to send off in a letter if needed, but in case a second shop drawing is likely to be needed later I use the other method. This consists of a sketch made on thin cross-section paper with a stylographic pen loaded with Higgins' Eternal ink. This ink has sufficient body to yield a fair blueprint, though it is not thick enough to clog the stylo. If a more elaborate thing is required than a rough free-hand sketch, I lay it off in pencil and then go over the straight lines with the stylo, and the circles and arcs with the regular bow-pen or compass, which is much easier than trying to follow a true curved line with the stylo held in the hand.

From these stylo sketches a very good blueprint can be made, and working drawings put in shape for the shop in a very short time. The sketches are filed in indexed envelopes, and the copybook sketches in colored pencil are all indexed in the back of the book, so in either case it is not much of a job to locate an old sketch.

While I believe in making drawings and sketches fairly complete as to minor details, at the same time I think a liberal use of the English language legibly written on the same sheet with the sketch goes a long way to prevent misunderstandings. If draftsmen themselves cannot all agree as to what a certain view of a drawing really represents (and such cases have been spoken of more or less in the technical papers) is it any wonder the man in the shop sometimes has to scratch his head more than twice to see things as the

draftsman wants him to? Of course a written direction can sometimes be read differently by two men, each giving it a meaning of his own, but if the sentences are clear and concise, as all technical writing should be, there is not much chance for trouble here.

I believe in using just as many short cuts in the drafting room, and in the machine shop, too, as is consistent with good work and freedom from misunderstanding and mistakes. The drafting room is a mighty poor place to save time in when the saving is done at the expense of clearness and certainty, but as it is results that count, and not methods alone, any short cut that eliminates what is actually useless work should be given a fair trial. It may work in some cases and not in others, for the different classes of work, workmen, and shops must be taken into account. There are few good things that are of universal application, and drafting room practice must be, in a degree at least, adapted to the particular needs of the case in hand. In some shops it might be best to show each and every detail of a piece on the sketch and do away with all written explanations and additions, but I find written notes very helpful in most cases.

Drafting, like mathematics, is only a means to an end, and a man who makes his drawings as if they were the goal instead of a part of the course is likely to put a pile of work into them which is really useless. The sun may always shine from the upper left-hand corner at the Patent Office, and shade lines are well worth all the extra time they take on a good many jobs, but a fair amount of common sense is better than too many rules and regulations in a drafting room as well as outside of it. E. R. PLAISTED.

Montpelier, Vt.

OLD EUCLID IS ALL RIGHT.

In regard to the article "Old Euclid Disproved at Last" published in the November issue allow me to say that the drawing is distorted. With the angle ABD as nearly 90 degrees as it is shown, the perpendicular HG would be so nearly parallel with EF that the intersection of the two would be removed nearly at an infinite distance. Line BD if produced would then intersect EF long before HG reached it. Therefore the triangle DBK is impossible. Old Euclid is perfectly able to take care of himself even if he has been dead so many many years, but it is a good catch all the same.

Buffalo, N. Y. GEO. B. SNOW.

OLD EUCLID DEFENDED.

In the November issue of MACHINERY "R. S." gives a remarkable proof (?) that Euclid made a mistake. In a case of this kind I think it is as bad to make a misleading drawing as to make a misleading statement. R. S. proved (?) that although the sides of one triangle are each equal to each of the sides of another triangle the angles were not of neces-

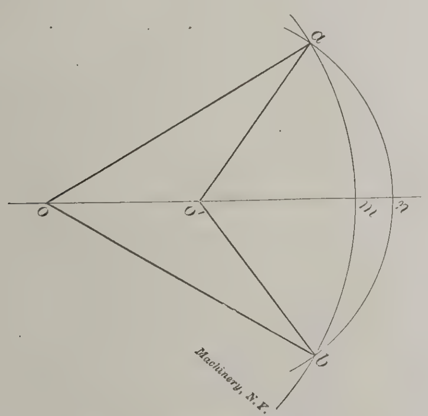


Fig. 1. Old Euclid Defended

sity equal. If his figure had been drawn correctly K would have been far enough away that DK would fall outside of point B. The above letters refer to his figure.

In Fig. 1 let amb and anb be the arcs of circles with centers at o and o'. From the definition of a circle o and o' must be equidistant from the points a and b. It is then easily proved that o and o' lie on the bisecting line of the angle $ao'b$ and aob, which statement must be true of any two arcs of circles intersecting in two points.

In Fig. 2 draw EE' (indefinite length) and AEB and $LE'C$ so that EE' is the perpendicular bisector of AEB and $LE'C$. Draw $BD = LB = AC$ so that angle DBA is larger than a right angle. Draw DC and erect a perpendicular at middle point H. EE' and HK intersect at K.

$CK = LK$, and $DK = CK$, as any point on a perpendicular bisector of a line is equidistant from the extremities; then

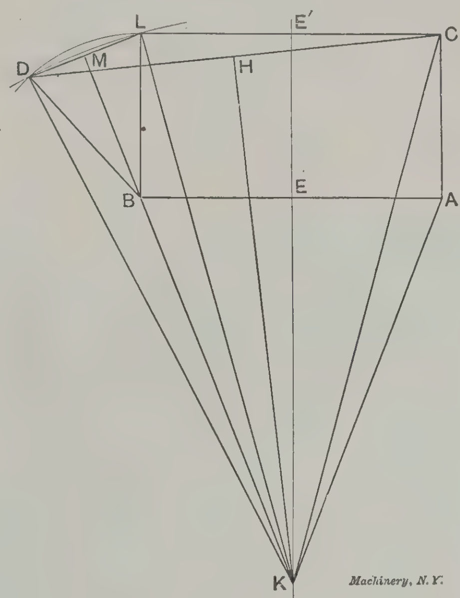


Fig. 2. Old Euclid Defended.

$DK = LK$ and an arc can be drawn through L and D with K as a center and also an arc through either L and D with B as a center. According to our proof in Fig. 1, B and K then lie on the line bisecting the angles DBL and DKL. It is then evident that the line combining D and K falls outside of the point B considered in relation to point A, and the whole proof in the "R. S." article becomes a nonentity. If this is not enough to convince "R. S.," who seems to be an extraordinary individual, the proof can be elaborated still further. The proposition reminds me of one I saw some time ago where a square 8 inches on a side was so cut and pieced together that it appeared to be 5 x 13 inches or one square inch larger than the square 8 x 8. Of course on close examination the fallacy of this was very apparent.

O. R. McB.

[Communications from readers upholding Old Euclid have also been received from E. A. Johnson, Hartford, Conn.; F. W. Barrows, Bridgeport, Conn.; C. J. Stuart, Montreal, Canada; W. L. Miller, Wellsville, Ohio; Arthur C. Garrecht, Easton, Pa.; Robert Cramer, St. Louis, Mo.; A. F. Sharp, Williamsport, Pa, and G. F. Key, Alpena, Mich. Their rigid stand on the question will undoubtedly convince "R. S." that there is no hope for the Nobel prize this year.—EDITOR.]

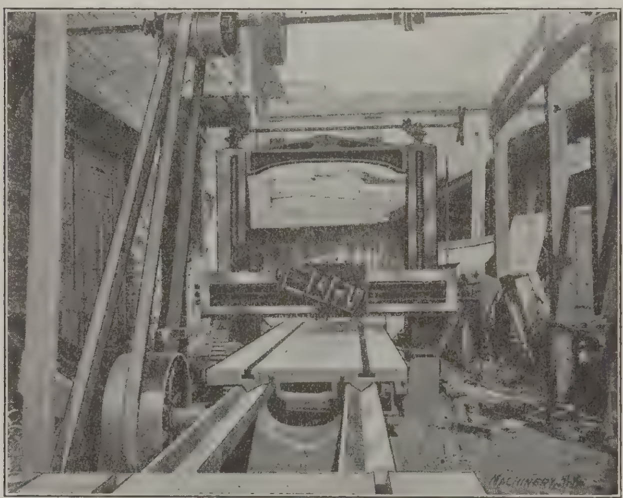
A MACHINIST'S CHRISTMAS PRESENT.

No matter whether we are running but a lathe or a whole shop, the question of Christmas presents presents itself to us with clock-like regularity. The great question of what to give *him* or *her* is before us. One might think that a machinist of all people concerned must buy his presents already made up, *i. e.*, that he cannot make anything worth while in the gift line. This is of course a great mistake, as any machinist who is good with the file can fashion watch charms galore, in different patterns from an anvil to a miniature locomotive. These would of course only apply to Harry and Fred, but if Eva is introduced, the patterns must be enlarged to the paper weight size. A very nice pin can be made by drilling and filing out the metal between the rim and head in a dime, leaving enough at top and bottom to hold it securely, then get some plating company to gold plate either the rim or the head (not both) for twenty-five cents, and add a safety pin to the back, completing as pretty a pin as any girl could wish for if the work has been carefully done. Of

course needle files are required to get into small corners. The operation might be reversed, and the head filed completely out, covering the back with a thin sheet of gold metal, which would make a very odd pin. Personally I prize a gift which has occupied the time and thought of the donor much above the "boughten" kind, and I feel sure that others share this feeling. W. L. McL.

AN OLD PLANER.

The accompanying halftone is made from a photograph of an old planer which is still capable of turning out a certain class of work, not requiring any great degree of accuracy. This latter statement is not to be wondered at when we consider that for over twenty years it has been in the great outdoor world beside the shop from which it receives its power. The bed of this planer is 45 feet long and it enjoys the dis-



An Old Planer.

tinction of having two tables, which can be used either singly or together, two in one as it were. The two bolts for coupling the tables can be seen in the picture projecting from the end of one table; the camera is on the other, the end of which is shown in the foreground. At one time the machine could boast of two heads, the connections for which can be seen at the right of the cross rail, but doubtless one of the operators wearied of thawing out any more parts than necessary to get the planer going after a snow storm and threw it off. The maker of this machine does not have to explain to a prospective purchaser that it is "full geared," a glance to the left between the pulleys and table will convince one of this fact.

The machine was built in England many years ago, and while being lowered into the vessel's hold for transportation had a foot knocked off. When it arrived here the buyer refused to take it, and told the steamship company to either get it fixed or give him the price of the machine. Not knowing what an easy matter the repair was, they quietly handed over the full price, and charged no freight upon delivering it to him, thus the lucky gentleman got it for the cost of the repair which would be dear at ten dollars. Should anyone coming around that shop inquire as to "what *it* is doing out there?" he will be at once enlightened by one of the boys, "Oh we keep that for planing up the weather." NEBALCM.

THE VALUE OF PROPER HARDENING.

The more I see of shop practice, the more I am convinced that few of us appreciate the value of properly hardened steel for tools and other purposes. My first recollections of early hardening operations show a small portable forge in which the fire pot was so small that air blasts must have hit the steel half the time and been responsible for many of the cracks that seemed mysterious at the time. Then too, I recall the warping of reamers and similar work, which had to be ground after hardening; taps that came out of the hardening water with numerous teeth missing, and milling cutters which looked as though a cyclone had struck them.

From what I now know, I believe most of these trials and tribulations could have been prevented if I had known of Mr. Markham's method of pack hardening. It is needless to say many dollars would have been saved my employer. Nor is this all; we are looking for steel that can cut 1,187 feet (more or less) a minute on rough work, but we lose sight of the fact that much of our work does not come under this head. This includes milling cutters both rotary and hollow, taps and dies and similar tools. They may come out of the bath whole and in good condition, but their cutting capacity is often below par. This may mean that a thousand-dollar milling machine is turning out a third less work than it should, and that it must be stopped entirely too often for grinding the cutters. This is by no means an exaggerated case, as there are numerous instances where a steel expert has greatly increased the amount of work by a proper hardening of the tools, and this with the same steel as before, or in some cases even a cheaper grade. Data on the subject of tool and cutting speed, that is, data which can be used as a guide in the average shop, is decidedly scarce.

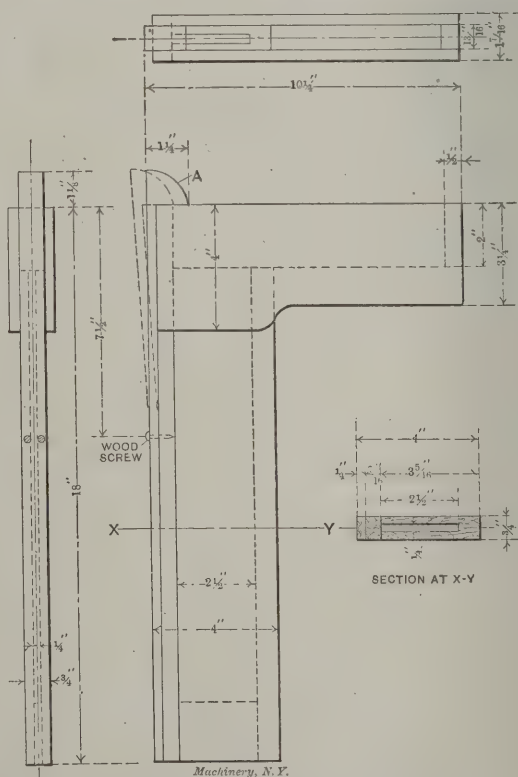
Some shops try to raise the speed themselves until the maximum is reached, which means that some cutters must be tested to destruction. In any large or even moderate-sized shop, it would probably pay to pick out a bright hardener and make it his duty to try to improve the working capacity of the tools. It does not pay to let a high-priced machine jog along all on account of a tool not worth over one per cent as much.

Then there is another side. It is the hardening, or perhaps, only casehardening of thin pieces which must be straight and true. If they warp, it's either a case of throwing away or spending time and money in straightening. Either way it is a loss which can be avoided if we just know how, and when we know that it is possible to prevent it, the sooner we do it the better. FRED H. COLVIN.

New York.

CASE FOR HOLDING AND PROTECTING LARGE SQUARES.

The accompanying cut shows a neat case for holding and protecting large squares when they are not in use in the machine shop. Machinists who have worked in various shops in the country claim it to be the best square case they have



Case for Holding and Protecting Large Squares.

seen. In the shop the case gets rough usage, but I have never heard of the latch permitting the square to fall out. The latch *A* is sprung back with the fingers when placing the square in or removing it from the case. The dotted lines

show the latch sprung back. All parts are firmly glued and the latch is fastened at a point about 7½ inches from the top with two small wood screws, preventing the same from being pulled off when it is sprung back. E. C. F.

BALL AND ROLLER BEARINGS.

George Le Guern.

The accompanying chart shows the result of experiments made in recent years by different firms on ball and roller bearings, from which experiments I have worked out the formulas and drawn curves. These formulas and curves are made for "safe working loads" for one ball and roller, which I think is the simplest and most practical way for the use of engineers and draftsmen. The matter is self-explanatory except it may be in regard to "three points ball bearings" where I have drawn the line MN parallel to line CAB, which not only assures a perfect radial contact between the three points, but prevents the balls from running over the lower path and does away with sliding between the top of the ball and the path.

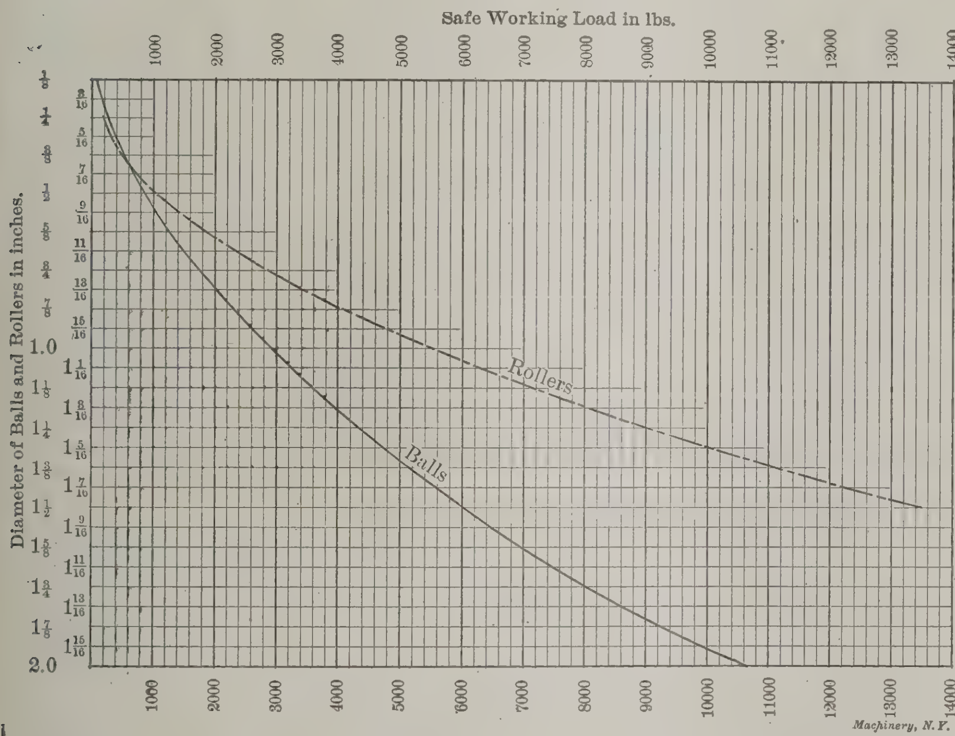


Fig 1. Chart giving Safe Working Load in Pounds for Single Ball and Roller.

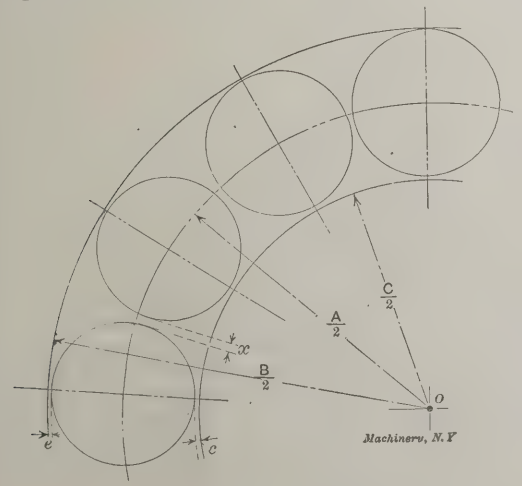


Fig. 2. Two-points Ball Bearing.

Formulas for ball bearing:

$D =$ diameter of ball

$N =$ number of balls.

Safe working load $= (D \times 10)^2 \times 31$

for balls up to 1 inch diameter, and

Safe working load $= (D \times 10)^2 \times 26.5$

for balls from 1 inch to 2 inches diameter.

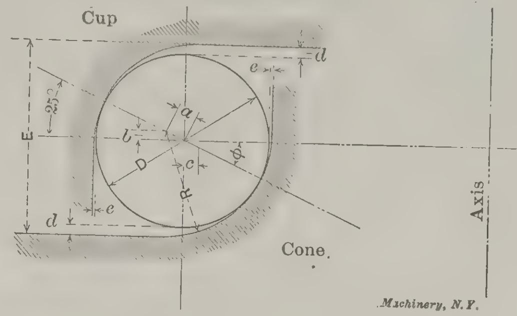


Fig 3. Two-points Ball Bearing.

Two points ball bearings: (Figs. 2 and 3.)

$x =$ clearance $= 0.003$

$a = 0.03125$

$b = a \sin 25° = 0.0132$

$c = a \cos 25° = 0.0283$

$$d = R - \frac{D}{2} - b = 0.018$$

$$e = R - \left(\frac{D}{2} + c\right) = 0.0029$$

$$A = \frac{D + x}{\sin \frac{180°}{N}}$$

$B = A + D + 2e$

$C = A - (D + 2e)$

$E = D + 2d$

$$R = \frac{D}{2} + 0.03125$$

Angle ϕ is figured at 25 degrees, which is good for general use. Where there is a great end thrust, angle ϕ is best made 30 to 45 degrees.

Three-points ball bearing: (Fig. 4.)

Make MN parallel to CAB.

Four-points roller bearing:

The upper part must be made same as the lower parts.

Formula for roller bearing:

Safe working load

$= [(D + k) \times 10]^2 \times 14$

where $D =$ diam. of roller in inches,

$k =$ term of an arithmetical progression, beginning at 0.1 for a roller ¼-inch diameter and having

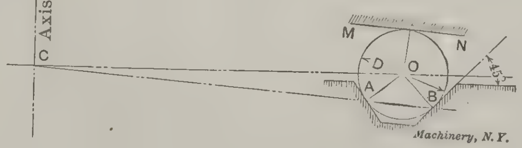


Fig. 4 Three-points Ball Bearing.

0.075 for a common difference, when the diameters of the rollers increase by 1-16 inch. Values of coefficient k for a number of diameters are as follows:

Diameter	Coefficient k	Diameter.	Coefficient k	Diameter.	Coefficient k
1/4	0.1	11/16	0.625	1 1/8	1.15
5/16	0.175	3/4	0.7	1 3/16	1.225
3/8	0.25	13/16	0.775	1 1/4	1.3
7/16	0.325	7/8	0.85	1 5/16	1.375
1/2	0.4	15/16	0.925	1 3/8	1.45
9/16	0.475	1	1.0	1 7/16	1.525
5/8	0.55	1 1/16	1.075	1 1/2	1.6

Washington, D. C. GEORGE LE GUERN.

A MARINE REPAIR JOB.

I wish to give some particulars of a marine repair job which may be interesting to a few of your readers. The high-pressure cylinder had broken at the top, a piece about 15 inches long and 5 inches deep being broken out and the cylinder wall fractured from one end of the break downward about 20 inches; the cover was also broken—leaving the flange on the studs.

The old liner, which extended up to the bottom of the steam port, was removed and a new one cast, being made the full length of the cylinder, with a flange at the top, as shown in

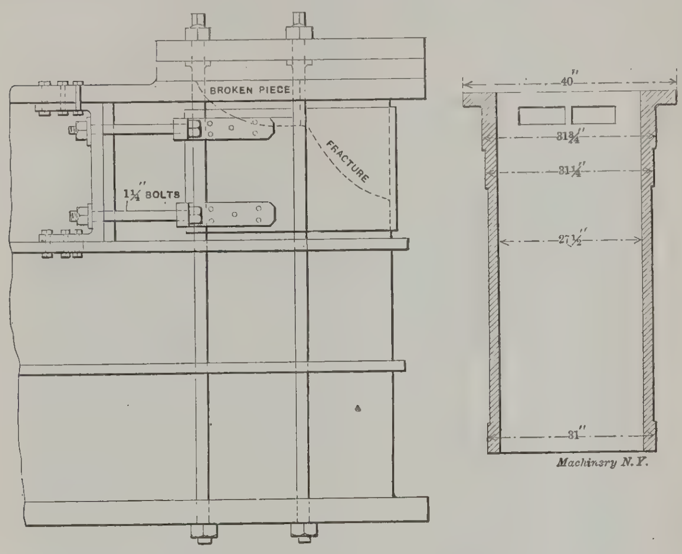


Fig. 1. General View of Repair Job and Section of Liner.

Fig. 1. New studs were made having a collar, as shown in Fig. 2, for which a corresponding counterbore was made in the stud holes in the liner. A square was left on the end of the studs, thus enabling them to be screwed tightly into the liner steam-tight, as the pressure carried was 200 pounds, liner and that of the cylinder. The liner was shrunk in, the cylinder being heated with steam. It was necessary to have the liner steam tight, as the pressure carried was 200 pounds, and if any leakage had occurred the broken wall of the cylinder would have had to bear the full pressure with obvious results. Above the top of the steam port the liner had only 2 inches of bearing surface, and as this was not considered sufficient to insure a good joint, two ¾ holes were drilled 2½ inches from each end of the port downward 1½ inch below the bottom of the port, a depth of 10 inches. Two copper dowels were then driven in tight and "staved up," so as to prevent any escaping steam from leaking round the fillet to the broken part.

In order to take the strain off the cover studs from the broken piece, two long bolts were used, one at each end of

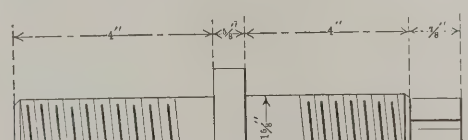


Fig. 2. Stud Provided with Collar for Fastening Liner

the break. They extended down through the bottom flange of the cylinder with nuts at each end and provided with a collar, the same as the studs. Two ⅞-inch studs were put through the broken piece and screwed into the liner, drawing the broken piece slightly up to the liner. A band made of 7/16 steel, 21½ inches wide, was placed round the top part of the cylinder and drawn tightly together by two 1¼ bolts, as shown in Fig. 1, the lugs on one side being bolted to the flange on the top and to a rib on the bottom. The job gave entire satisfaction and saved the large expense of making a new cylinder, which was first intended, not to speak of the delay to the steamer which that would have necessitated.

"PROPELLOR."

A FEW "WRINKLES."

It is a mistake to suppose that "wrinkles" and methods already known, perhaps, to "old hands" or specialists, are without interest or value to the readers of engineering journals. Recruits are constantly being enrolled both in the engineering and machinists' trade, and also in the company of those who believe such journals instrumental in broadening their outlook on their vocation. Therefore I do not apologize for presenting the following matter, each item mentioned in which has been personally tested, if not actually originated, by me.

Collars of wrought or gray iron or steel, the bore of which from any cause has worn too large, or which on new work has been bored a "shade" too large, may often be made serviceable again by heating to red heat and allowing to cool slowly, repeating this process several times. It is really surprising sometimes to what an extent the bore may be reduced by this means. This feature has often to be taken into account in the design of steam boiler and other furnace grates, as the firebars, etc., "grow" in length or bulk by repeated heating and cooling, especially when fires are regularly banked.

The profitable all-round utility of bright drawn, round machinery steel (cold-rolled steel) is somewhat limited by the fact that it is generally supplied in sizes suitable for *revolving* in standard-sized holes. If a gear, collar, cam, or analogous article is desired to fit tightly, it must be bored smaller than standard size, which is an unprofitable process. This drawback may be completely removed by knurling with, say, a Pratt & Whitney knurling tool the part of the shaft or spindle where the tight fit is required, any degree of tightness of fit being easily obtainable. Oil should be used when pressing the article on the shaft or spindle. The appearance of the knurled part is not at all unpleasing. Another advantage of this method is that collars, gears, etc., which require fastening by taper pins at definite distances from each other—and still must be easily removable—may be tightly held while being drilled and reamed, and afterward the knurled portion of the shaft may be eased to give the exact push fit required. This is no "botch" job, as it fulfills any requirements for a good job, viz.: it looks well, acts well, and is cheaply produced. It has been used in hundreds of cases within my own knowledge, without a single failure or complaint being heard of.

The reaming of taper holes in mild or machine steel, tough bronze, etc., is, in the ordinary way, a somewhat tiresome and costly process, as the ordinary fluted reamer is liable to attempt to "bite off more than it can chew," thus coming to grief by breaking completely or losing its teeth by chipping. A certain amount of special pleading or tenderness in manipulation of the reamer is therefore called for. If, however, the taper reamer is made with two flutes only, after the manner of a twist drill, the flutes having a left-hand spiral, and backed off so as to cut right-handed, if a hole the size of the smallest end of the pin is first drilled through the work, a reamer of the style described may follow at the same setting of the job, and be used at drilling speed. In a particular case I can mention, since the employment of this type of reamer, the piece-work price has been reduced 50 per cent and the men can earn more money than previously.

JAMES VOSE.

* * *

While high-speed steel has proven itself to be of great usefulness for cutting tools of general description such as lathe and planer tools, milling cutters, reamers, etc., it has not as yet proven practicable to make such tools as taps, threading dies and chasers, which cannot be ground after hardening, of this material. The reason for this is that most grades of high-speed steel have to be heated to such a high temperature when hardening that the sharp edges of the tools to be hardened are practically melted away, and as a rule, unless the tool is of such a construction that it can be ground after hardening, it is almost useless for cutting purposes. It is not to be inferred from this that taps and threading dies are impossible to make from high-speed steel, but the difficulties encountered in trying to successfully harden these tools are such that prominent manufacturers hesitate to undertake the making of tools not possible to be ground after hardening from this material.

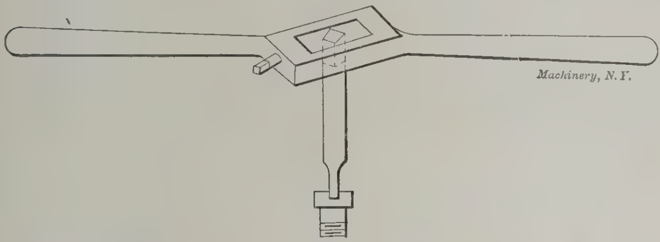
SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

A HANDY SCREWDRIVER.

The accompanying cut shows a cheap, handy and very powerful screwdriver made out of a piece of tool steel. Flatten one end for the screw slot, either by forging, grinding, filing, or milling, and square the other end; harden and temper.

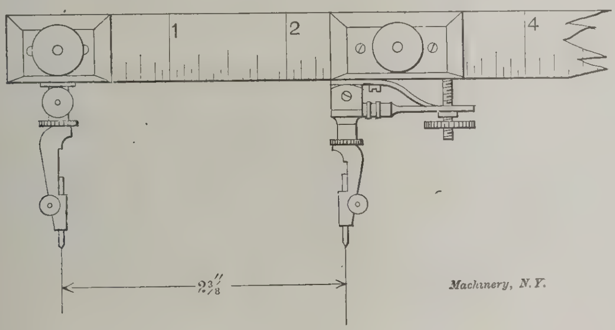


Use an ordinary tap wrench as a handle. Run the screw in with an ordinary screwdriver, and then tighten it with this tool, if the screw is large enough to require it. One can also use a monkey wrench or a dog on it, in an awkward place.

Beverly, Mass. CHARLES E. BURNS.

SCALE FOR BEAM COMPASS BAR.

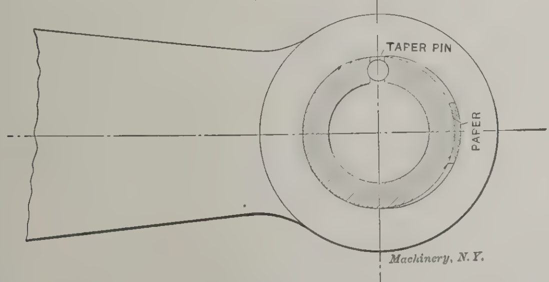
Beam compasses can be improved by placing a scale on the beam as shown. I had intended to purchase a paper scale engine divided in sixteenths and paste it on the beam, but finally decided that a linen tape measure would answer the purpose. There was no cost for this, as it was one furnished



by an advertiser, and on account of it being thin was better than could be bought. A coat of shellac keeps it clean and the divisions distinct. The object of the graduations is simply to get the pencil point approximately set, the finer adjustment then being made. WINAMAC.

TAKING UP WEAR IN A SOLID BUSHING.

After forcing the bushing out, I split it lengthwise with a hacksaw, cutting a slot about ⅛ inch wide; then I put two thicknesses of writing paper in the connecting-rod hole, on the side opposite to the pressure, clamped the bushing together, and slid it into the hole. Then I ran a taper reamer down into the slot, and drove a taper pin into it, very solidly; I

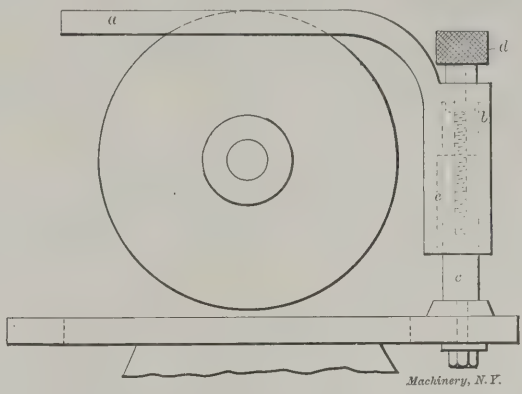


tried it in the arbor press and the bushing was a good pressing fit. The hole had been closed up just enough to be a good fit on the wristpin, and it also left a way open for future adjustments. The job has been in running condition five months already. CHARLES E. BURNS.

Beverly, Mass.

SURFACE GRINDING ATTACHMENT.

The cut shows a surface grinding attachment which can be used on any ordinary grinder and which I think is more handy than the one described in an article in the September issue of MACHINERY. Not every shop has a spare set of lathe legs as mentioned in that article. A stud with a nut and washer



holds this attachment to the slot provided on most grinders for holding the rest. The table *a* has a sleeve *b* on the lower side which slides on the post *c*. It is raised and lowered by the knurled head *d* of the adjusting screw. The key *e* prevents the table from turning on the post. H. K. G.

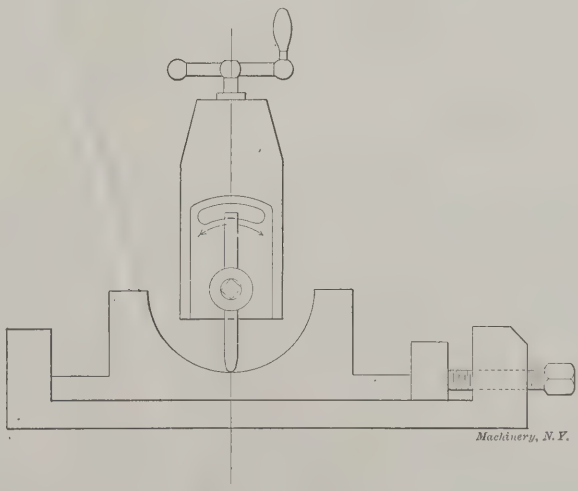
A SIMPLE SAFEGUARD FOR INK BOTTLES.

A very cheap and effective way of preventing ink bottles from being upset on the drawing table came to my notice recently. Simply cut a piece of card-board about 3 or 4 inches round or square, spread a thin coat of any good mucilage or liquid glue on the bottom of the bottle and set it in the center of the card-board. That's all. For the want of something more substantial, which is sometimes not to be had, this method does the trick very nicely.

Chicago, Ill. ROBT. A. LACHMANN.

PLANING AN ARC WITHOUT A RADIUS BAR.

There were some gray iron boxes and caps, which were too small in the bore to allow of sufficient babbitt metal between the shaft and the casting. To chuck them up in a lathe would have been expensive, so I placed them in the vise of a heavy shaper, and set a round-nosed tool with a long shank so that from the cutting edge to the center of the holder was the radius of the required boxes. Starting at the bottom, I fed from left to right by successive blows of a hammer on the shank, giving it all the cut the machine would pull, as



smoothness was no object. After finishing one half I loosened the tool and returned to the bottom, doing the rest by hammering the other side of the shank. This was much better than trying to start at one side and go the whole half circle, not only because the feeding would be more difficult, but greater inaccuracy would result if the tool shifted. This can be worked, when necessary, on a lathe without a compound rest. The trick is not new to many, but doubtless to the younger generation it will be. W. M.

SHOP RECEIPTS AND FORMULAS.

A DEPARTMENT FOR USEFUL MIXTURES.

This page will be used for the publication of shop receipts which the contributors know from experience to be practicable. Nearly all readers of MACHINERY can add something, and it is desired that they use this page as a medium for exchanging useful formulas. It makes no difference if they are old and supposedly well-known, provided they have not already appeared in this department.

268. SOLDERING GALVANIZED IRON.

For soldering galvanized iron without scraping use raw muriatic acid. WM. DAVIS.

Philadelphia, Pa.

269. CEMENT FOR LEATHER.

One ounce shellac, 2 ounces pitch, 2 ounces linseed oil, 4 ounces caoutchouc, 1 pound gutta percha. Melt together and apply hot. E. H. McCLINTOCK.

West Somerville, Mass.

270. NON-RUST SOLDERING SOLUTION.

A good anti-rust solution for soldering metals where acids must not be used, is made by dissolving rosin in acetone, making a solution about as thick as molasses; it is applied in the usual manner. W. R. BOWERS.

Birmingham, Eng.

271. TINNING WASH FOR BRASS WORK.

To prepare a tinning wash for brass work, use 6 pounds of white argil (potter's clay), 4 gallons of soft water, and 8 pounds tin shavings. Boil the brass work in this solution for 15 or 20 minutes. W. R. BOWERS.

Birmingham, Eng.

272. BLUING IRON OR STEEL.

Mix one part clean sand with one part powdered charcoal, heat the whole evenly in a pan or convenient receptacle until the piece, which has first received its finishing polish and been covered by the mixture, comes to the desired color. When cool, wipe dry with cloth. NERALCM.

273. ENAMEL GLAZE FOR COATING IRON PANS.

To prepare an enamel glaze for coating iron pans use flint glass, 130 parts; carbonate of soda, 20.5 parts; boracic acid, 12 parts. Dry at a temperature of 212 degrees and then heat to redness and anneal, that is, cool down very slowly.

Birmingham, Eng. W. R. BOWERS.

274. CEMENT FOR CAST IRON.

Mix 1 pound cast-iron filings, 1 ounce sulphur, and 2 ounces sal-ammoniac. Mix thoroughly and keep dry. When using, mix one part of this composition with twenty parts clear filings and some very fine sand. Make into a stiff paste with water. E. H. McCLINTOCK.

West Somerville, Mass.

275. PRESERVATIVE OIL.

To make a preservative oil use high test grain alcohol and best grade of sperm oil, equal parts. Keep in a tightly-corked bottle, and shake well before using as the alcohol and oil separate after standing. Any moisture on a tool or gun at the time of application is quickly absorbed by the alcohol which in a short time evaporates, leaving a good coat of sperm oil to protect the surface from rust.

E. W. NORTON.

276. CEMENT FOR STEAM-PIPE JOINT.

A good cement for use in making steam-pipe joints is made in the following manner. Grind and wash in clean cold water 15 parts of chalk and 50 parts of graphite. Mix the two together thoroughly and allow to dry. When dry regrind to a fine powder, to which add 20 parts of ground litharge and mix to a stiff paste with 15 parts of boiled linseed oil. The preparation may be set aside for future use, as it will remain plastic for a long time if placed in a cool place. It is applied to the joint packing as any ordinary cement and will be found to last a very long time.

Olney, Ill. T. E. O'DONNELL.

277. ANNEALING STEEL.

Heat slowly or rather evenly to a dull red heat. Put it in a dark place or corner, box or barrel, until all signs of red have just disappeared, then quench in water, taking care to hold it still. When annealing flat stock, heat evenly and thoroughly, place between two planed pine boards on an ash heap and cover with ashes. By this method the charcoal is produced, so to say, automatically. WM. B. BROOKS.

New Kensington, Pa.

278. TO ANNEAL ZINC.

In working zinc the greatest loss is on account of the zinc cracking and being too brittle to handle to advantage. It is surprising to find how very few mechanics understand the annealing or malleablizing of same. The following will be found unfailing: Heat in oil to about 500 degrees F. and plunge in hot soda water, which works the double operation of drawing the zinc to the proper degree and at the same time cleanses the surface from the oil. HARDENER.

279. COLD SOLDER.

For flux use 1 part metallic sodium to 50 or 60 parts of mercury. These combine if well shaken in a bottle. For solder use a weak solution of copper sulphate, about 1 ounce sulphate to 1 quart of water; precipitate the copper by rods of zinc, wash the precipitate two or three times with hot water, drain off the water and add 6 or 7 ounces of mercury for every 3 ounces of precipitate. A trifle of sulphuric acid will assist in the combining of the matter. The combination will form a paste which sets very hard in a few hours.

New Haven, Conn. A. L. MONRAD.

280. TINNING CAST IRON.

To tin cast-iron articles, dissolve chloride of tin in water until the solution is fully saturated; this saturated solution is to be thinned down when needed for use, by ten times its volume of water. The articles which are to be tinned are to be wrapped around lightly with zinc sheet or wire and left in the solution ten to fifteen minutes. On removing the articles they are to be dried in sawdust, after washing well with clean water and brushing them with a wire brush, and then polished with prepared chalk. ROBERT GRIMSHAW.

Hannover, Germany.

281. RETOUCHING BLUEPRINTS.

An excellent solution for retouching or marking in details on blueprints can be prepared according to the following receipt. The solution consists of 75 grains of potassium oxalate dissolved in 1 ounce of water. If the solution is too thin and watery, it may be thickened by adding some kind of a gum preparation. It can be applied with a pen, as ordinary ink. The blue background is removed very rapidly by the solution, but it is important that the print is immediately washed, as the solution has a tendency to soak into the pores of the paper and blur the lines. T. E. O'DONNELL.

Olney, Ill.

282. TO PREPARE FINE ABRASIVE QUICKLY.

To quickly prepare fine abrasive use FFF emery or "15-minute" carborundum with benzine or naphtha for a liquid, mixing them in a square bottle. Use about two ounces of the abrasive to one quart of liquid; shake well and then lay the bottle flat on its side for the number of minutes wanted to settle; then pull the cork and let the liquid flow out until level with the cork hole bottom. The liquid just drawn off can be used at once with a brush, but by allowing it to stand for a time, the top portion can be poured off leaving the abrasive with a little benzine which will evaporate quickly, and leave the clear powder.

In explanation of the term 15-minute carborundum, would say that this is a term applied to fine abrasive obtained by the process just explained (manufacturers, of course, using watertanks instead of bottles), the time the liquid is allowed to stand, in minutes, being used to distinguish it. Thus, if it stands 15 minutes it will be known as 15-minute abrasive, etc.

SCOTTY.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

29. G. E. R.—Why is it that a stud and nut can be screwed up tighter than a tap-screw?

A.—We know of no good reason for such a condition existing; the effect of friction and torsional elasticity should be exactly the same in both cases. But lack of exact alignment, of course, affects a tap-screw more unfavorably than a stud and nut. It is true that a tap-screw will loosen quicker when subjected to vibration but this comes from the stud being screwed in until it shoulders on the tapered part of the thread while the tap-screw cannot be screwed to this point, hence is more easily jarred loose.

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30. R. O. F.—What is the essential difference between the Willis and Walker system of cycloidal gearing?

A.—The Willis system is based on a single generating circle, the diameter of which is equal to the radius of the smallest gear in the interchangeable set. For example, suppose the Willis system is applied to a set of 3-inch circular-pitch gears, and it is desired that the smallest gear in the set shall have 15 teeth. Then the diameter of the generating circle will be 7.16 inches, which simply means that the faces and flanks of the teeth of the various gears will be shaped to conform with the curves generated by a point on a circle 7.16 inches diameter, rolling on the pitch circle of all the gears of the set. The Walker system is based on the same general principle as to using a rolling circle to generate the tooth shapes, but a single generating circle is discarded. Say the limits of an interchangeable set of Walker's gears are 10 and 200 teeth. Then the tooth shape is determined both with a 10-tooth and a 200-tooth generating circle, the tooth shape selected being a mean between the two for the faces or tooth parts above the pitch line; below the pitch line the flanks are shaped to the mean down to a certain depth and then the mean shape is departed from in order to give the necessary clearance for the top of the teeth for all the gears of the set. This system to a considerable degree overcomes the defect of under-cutting unavoidable with the Willis system on low-numbered gears, and is claimed to make a material improvement in the action in general.

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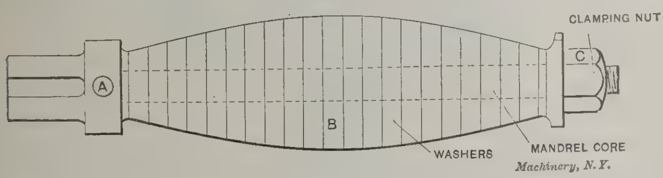
31. A. L. M.—I wish to coil a few wire handles large in the center, similar to those used on stove-lid lifters. What kind of a mandrel is used for this work?

A.—Wire coils of this shape are manufactured on special wire coiling machines which require no mandrel, the coil being formed in mid-air, so to speak, by exterior rollers which automatically change position during the operation so as to



vary the diameter of the coil and thus make it of the required shape, *i. e.*, large at the center and small at the ends. For making a few such coils, however, you may use the form of mandrel shown in the cut, using it in an engine lathe in the usual manner. It consists of a number of thin steel washers mounted on a mandrel and turned to the required shape; they should be consecutively numbered so as to be readily replaced in order. The end of the wire is caught in the hole *A* made in the solid part of the mandrel, and the coiling is done on top of the washers *B*, the nut *C* keeping them close together. When the coil has been completed the removal of the nut allows the mandrel core to be removed and loosens the washers, which with a little rapping will fall out between the coils, if they be not too closely wound. This design of mandrel cannot be used for close wound coils unless very thin washers are employed. It is only recommended for experimental purposes and not for manufacturing.

32. A. L. B.—What is the use of a table of logarithms?

A.—A table of logarithms is of the same order of importance to the operations of multiplication and division that the multiplication table is to addition and subtraction. It is a great time-saver, and is practically indispensable for computation in which fractional powers are to be expanded, or fractional roots are to be extracted. For example, suppose the expansion of $189^{1.41}$ is required. The expansion is readily done by the use of a table of logarithms, but is impracticable by any other method within the reach or time of the ordinary calculator. Again, take such a calculation as finding the amount of \$1.00 at compound interest for 50 years at 8 per cent semi-annually. This is an almost interminable operation, conducted in the primitive manner, but it is simple with logarithms. To illustrate we will work out the example. The primitive calculation requires that \$1.04 (the amount of \$1.00 at 8 per cent for 6 months) be multiplied by itself 100 times, but using logarithms makes only one multiplication necessary. The logarithm of 1.04 is 0.017033; multiplied by 100 it is 1.7033, or the logarithm of the amount of \$1.00 for the given time and rate. The table discloses this to be 50.50. Hence the amount of \$1.00 for the given time and rate is \$50.50. To expand $189^{1.41}$ we simply find the logarithm of 189, and multiply it by 1.41. The logarithm of 189 is 2.276462, which multiplied by $1.41 = 3.209811$. Turning to the table it is found that 3.209811 is the logarithm of 1621.1, and this is the required expansion of $189^{1.41}$. By dividing the logarithm of 189 by 1.41 the 1.41st root is extracted, and so on.

* * *

SHORT LIFE OF MODERN HEAVY ORDNANCE.

The annual report of General Crozier, chief of ordnance, gives a startling idea of the short life of our 12-inch guns now in place in most of the coast fortifications of the United States. The report states that a 12-inch gun firing a projectile with a muzzle velocity of 2,500 feet per second will last for only about sixty rounds, after which the accuracy of fire is seriously impaired by erosion, which wears away and destroys the rifling. It is pointed out that the guns in any of the important fortified works of this country would last less than two hours in an engagement requiring rapid firing. General Crozier suggests that the caliber be increased to 14 inches and the velocity decreased from 2,500 feet to 2,150 feet per second, stating that the life of the gun is then increased to 200 rounds, and the penetration or smashing effect would be about the same.

The suggestion to reduce velocities and use larger calibers is one which we think will not be favorably received by military authorities in general. If it be considered that the life of a modern 12-inch gun firing projectiles with a velocity of 2,500 feet per second is only sixty rounds the situation is indeed serious, but high velocities and smaller calibers are the tendencies in both heavy ordnance and small arms. The thing to do is to find some material for lining high-powered guns which will not be affected by the incandescent powder gases as much as the steel now used. The suggestion has several times been made that high-speed steel is a material well adapted for such a purpose, inasmuch as it gains in hardness with an increase of temperature up to a low red and this is exactly what is wanted for the liner of a heavy rifled gun using smokeless powder. High-speed steel was developed in the manufacture of arms and armor and it would not be strange if it, itself, should become a necessary part of modern guns.

* * *

The substitution of machine steel for purposes for which carbon steel was formerly employed is one of the improvements about which little is heard. Nevertheless, some large concerns use it almost exclusively for dies, taps and other cutting tools which require toughness as well as hardness. A machine steel tap when skillfully casehardened will cut as freely and is said to wear practically as well as one of carbon steel. Besides being cheaper to make, it will not snap off suddenly when subjected to undue stress. We understand that the Singer Manufacturing Co. use little carbon steel in their Elizabethport works, and that all punches, dies, taps, etc., are generally made from machine steel, casehardened.

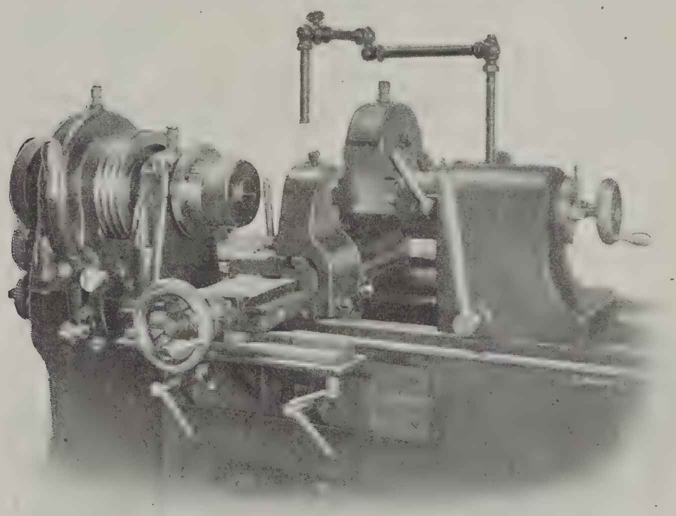
MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

TAPER ATTACHMENT FOR THREAD MILLER.

This attachment is designed, as shown in the cut, to be applied to the 6 x 48 Pratt & Whitney thread milling machine at the time the machine is built. In operation and general construction it is similar to the well-known Slate taper attachment for lathes. The taper bar is made in two parts, the one nearer the headstock being secured in a position parallel to the working centers, while the other is made adjustable to suit the required taper. This permits the threading of pieces which have both a taper and a straight portion. The bracket upon which the taper bar is mounted is attached to the front side of the bed in such a way that it may be shifted and clamped in any longitudinal position to agree with the location of the taper on the piece whose thread is being milled.

The cutter head is carried on a transverse slide to which is also attached the cross slide screw with its micrometer disk and positive stop, thus providing means for adjusting the position of the cutter for diameter of work and depth of cut in-



Taper Attachment for Thread Miller.

dependently of the mechanism of the taper attachment. The cross movement imparted by the tapered bar is communicated to the slide through the action of the positive shoe attached to it, held in contact with the front side of the taper bar, through the action of a roll under adjustable spring pressure on the rear side. The greatest angle to which the taper bar may be adjusted is 10 degrees, corresponding to about 4 inches taper per foot. All the required adjustments may be made without the use of a wrench. The Pratt & Whitney Co., Hartford, Conn., are the builders.

IMPROVED FOX TRIMMER.

The well-known universal trimmer made by the Fox Machine Co., 815-825 N. Front Street, Grand Rapids, Mich., has been redesigned and improved in a number of particulars. The rigidity and weight of the machine has been increased while its portability is still retained, it being mounted on three casters so that it may be easily shifted from place to place as required. A slight forward pull of the handle shown at the base of the machine in Fig. 1 raises it from its foundation onto the rollers, and the returning of the handle to the upright position settles it firmly on its base again. Other improvements relate to the means provided for taking up the wear of the cutter slide while still preserving the accuracy of the machine. Improved gages are also provided, both for angular cuts and straight work, while provisions are made for easily and accurately setting curved segments to bring the trimmed edge accurately radial and at the proper angle.

For plain angular work, the gages shown on the table in Fig. 1 are provided. A pivot block working through the curved slot in the table is fitted to the bottom of the gage by means of a carefully milled groove and tongue, and held by two heavy screws. The broad bottom of the gage rests flat on top of the bed of the machine while the pivot block underneath presents four carefully scraped and fitted bearings to the under side of the bed. This construction holds the gage rigidly. The pivot block has its center line directly on the

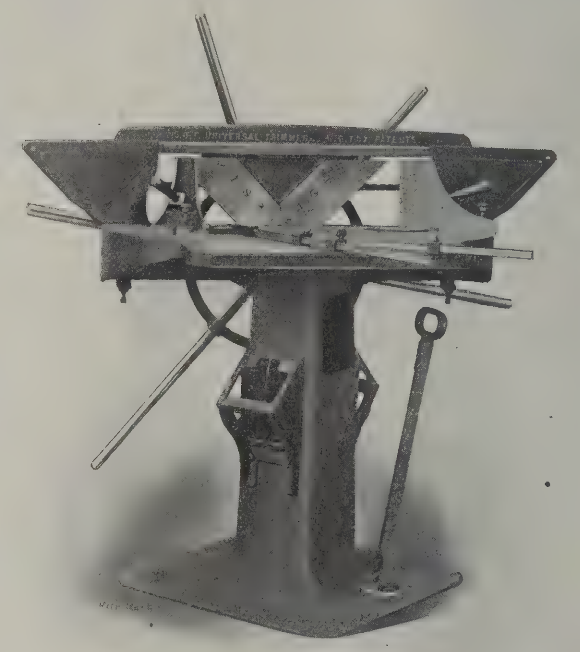


Fig. 1. Improved Fox Trimmer. Front View.

spot where the cutting edge of the knife and the point of the gage meet, so that in swinging the gage, it is constrained to move in a true arc of a circle with the gage point always at exactly the same spot. This design does away with the inaccuracies which come from wear with the usual construction and hold it so rigidly that it is possible to set it with spring taper stop pins without locking it by the clamping lever. Even under these conditions a heavy cut may be taken

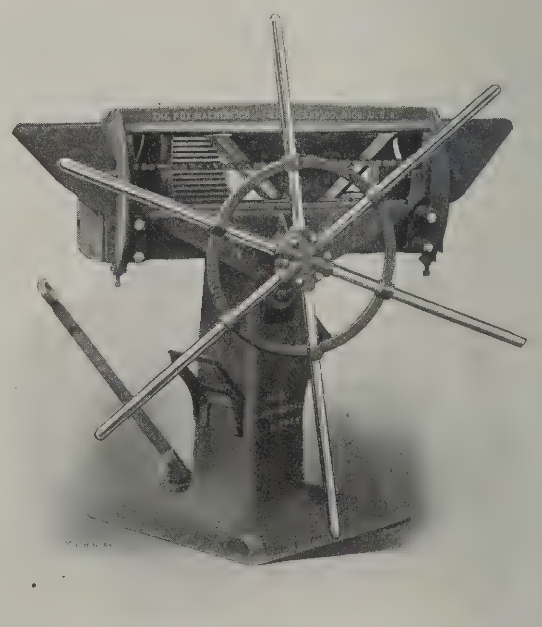


Fig. 2. Improved Fox Trimmer. Rear View.

without springing the gage perceptibly. Forty-five degree angle blocks are provided for tenoning and for work requiring double angle trimming. When not in use these rest in brackets provided for them on the column.

The line cut, Fig. 3, shows the design of the segmental gage supplied with this line of trimmers. The bed is laid

out for trimming segments of circles of 3, 4, 6, 8 and 12 segments to the circle, for diameters ranging from 6 to 95 inches. While universal trimmers have often been used on this work, hitherto close work has been impossible, the inaccuracy of the band sawing affecting the trimmed end. The new stop rod attachment shown limits this inaccuracy. The head which locates the outer end of the work can be pressed inward against the resistance of the spring mounted within it. In trimming the first end of the segment this head is pressed in. As the piece is reversed to finish the other end, the gage springs out again to the proper position for cutting the true angle on the other ends, the gaging being done from the already completed surface. The result of this is the elimination of the cut-and-try process in finishing the last piece.

Tabulated instruction plates are fastened to the knife guards at each side of the machine. That at the right hand contains a table giving the number of sides, center angles, angles between adjacent sides, radius of circumscribed circle, radius of inscribed circle and angle of setting for polygons of from 3 to 12 sides. Rules are also given for obtaining the length

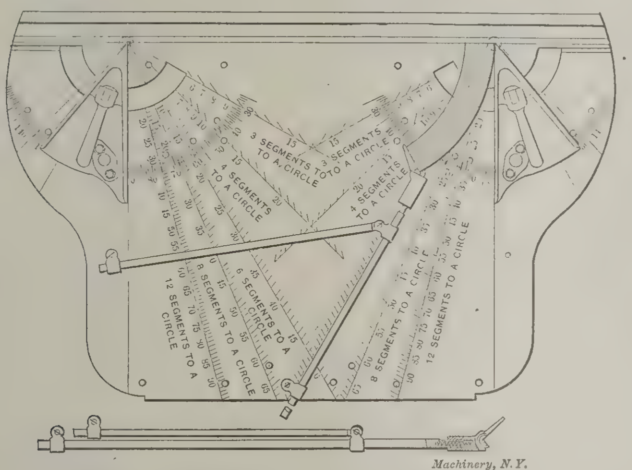


Fig. 3. Arrangement of Segment Gage Graduations on Surface of Table.

of a chord of a given segment. The other plate shows a graphic solution for finding the lengths of segments of a circle. This is intended to give the workman the number of degrees of a circle contained in a segment or triangle.

TWO NEW PRATT & WHITNEY PRODUCTS.

The Pratt & Whitney Co., Hartford, Conn., are now prepared to furnish their profiling machines in either the belt driven or spiral gear driven forms to suit the requirements or fancy of the purchaser. The use of belts is preferred to a spiral gear drive, as formerly provided, in cases where small cutters and excessive speeds are required. The No. 11 machine, for instance, when belt driven, may have as high a spindle speed as 2,500 to 3,000 revolutions per minute if the work requires it, thus adapting it to operations on the softer metals as well as iron and steel. The spindles are driven from a drum at the rear of the machine. The driving pulleys of the spindles are mounted on sleeves entirely independent of the spindle bearing. All the revolving parts including the drum and the pulleys are carefully balanced so that they may run at a high speed without vibration.

Another recent addition to the list of appliances made by this firm is a tool post grinder designed particularly for use with their bench lathe. The frame of this grinder is a steel casting with a shank of suitable form for holding in the regular tool post of the machine. The spindle is of tool steel, hardened and ground, with straight bearings running in bronze boxes, which are split, tapered on the outside and mounted in steel bushings with a nut at each end, by which the adjustment can be easily made to compensate for wear. The journals are thoroughly protected from grit and dust. The spindle has a tapered hole to receive the small arbors on which wheels for internal grinding are mounted, while the outside of the nose for the spindle is tapered to receive a wheel mount for external work. Oil for the spindle bearings is introduced at the rear end of the spindle, which is hollow and serves as a reservoir. When provided with small cutters on tapered sleeves this tool may also be used for light milling and drilling.

THE "JUST IT" LATHE TEST INDICATOR.

This little device is made by Mr. A. E. Babin, Waterbury, Conn., and is designed particularly for truing up work in the lathe, either from surfaces already finished or from prick

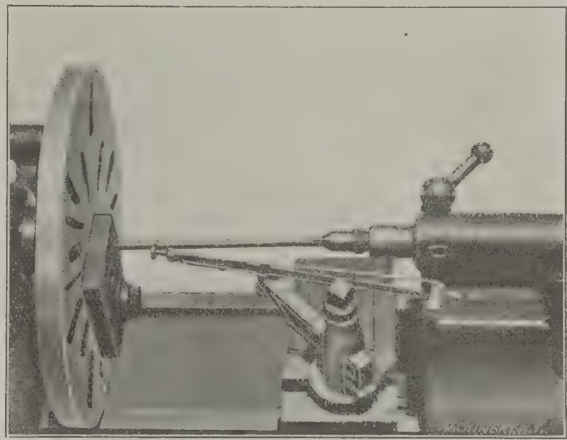


Fig. 1. The "Just It" Lathe Test Indicator Centering a Prick-punch Mark.

punch marks. Fig. 1 shows its use as a centering indicator. A bar is furnished having one pointed end and the other end centered. The pointed end is inserted in the prick punch mark of the work, while the centered extremity is held by the tailstock center, which is brought up to give it enough pressure to retain it firmly in place. The head of the indicator may then be brought against the end of the bar near the work and the error in setting found by noting the amplitude of the vibrations at the outer end of the needle. When used for truing a piece up from an exterior or interior surface, the end of the indicator is applied directly to the work.

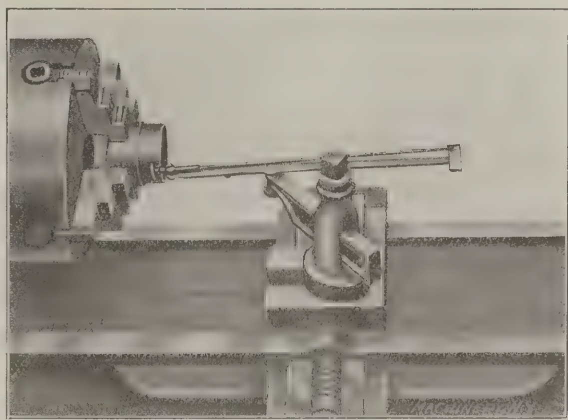


Fig. 2. The Indicator in use Truing the Outer Surface of Work Held in a Chuck.

The long distance from the head to the point where it is attached to the shank makes it very valuable for use with deep holes, as well as for work on the faceplate or planer where bolts and straps are used which would interfere with the ordinary indicating device.

HORIZONTAL BOILER RIVETER INSTALLATION.

The Chester B. Albree Iron Works Co., Allegheny, Pa., build a horizontal boiler riveter of a design different from the usual style in this country. The riveters employed in the boiler shops as a rule are vertically set machines, requiring a deep pit and high clearance for the crane overhead. In the design referred to above which is used to a great extent in Germany, the riveter is suspended horizontally from a trestle. The machine proper is supported by the trestle and is raised and lowered by means of a hand crane; a truck is provided for carrying the boiler back and forth during the riveting. On the top of this truck are placed six small rollers upon which the boiler rests during the riveting operation. These rollers are so arranged that the boiler may be rotated about its horizontal axis, thereby making it possible to bring any

part of its circumference under the riveting die. The manufacturers claim that this style of machine can be installed for half the price of a vertical stationary air compression riveter. The space saved by installing this style of apparatus may also, in many cases, be of importance.

THE FORTIN UNIVERSAL JIG.

The constant improvement taking place in the product of all manufacturing establishments means a constant change in the design and dimensions of the parts produced. Where these parts are made in such quantities as to warrant the use of jigs for the drilling, tapping, and reaming operations, this change in shape and dimensions involve a serious expense in the alterations thus made necessary in these tools. The B. P. Fortin Tool Co., Woonsocket, R. I., have designed and placed on the market a "universal jig," illustrated in the photographs and line cuts, Figs. 1 to 4. This tool is intended to be adapted to all ordinary work within its range, thus avoiding the necessity for a great number of jigs and the expense

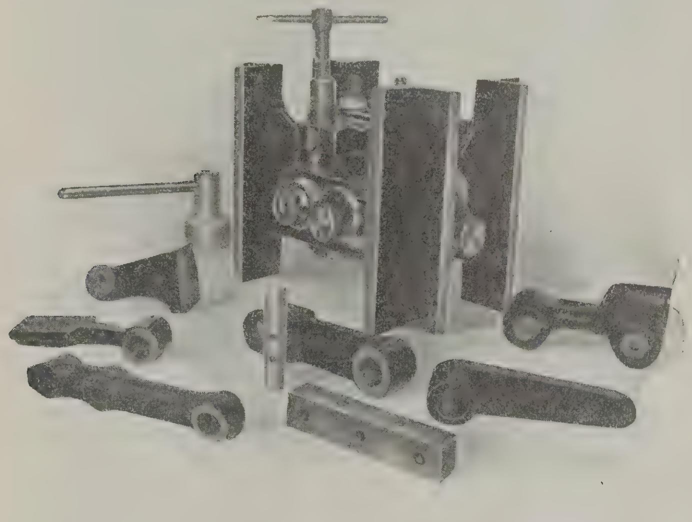


Fig. 1. The Fortin Universal Jig and Samples of Work.

of alterations and rebuilding consequent on changes in design, as described above. The main idea of the device is that of a rectangular box with a hinged cover. In each of the five sides, and the cover as well, slots are formed in which the required stops, clamping screws, locating surfaces, and drill bushings are fastened. In Fig. 1 the device is shown with its cover closed, and grouped about it is a collection of parts giving some idea of the variety of work to which it is adapted. Fig. 2 shows the jig tipped up with the cover open and a piece of work in place.

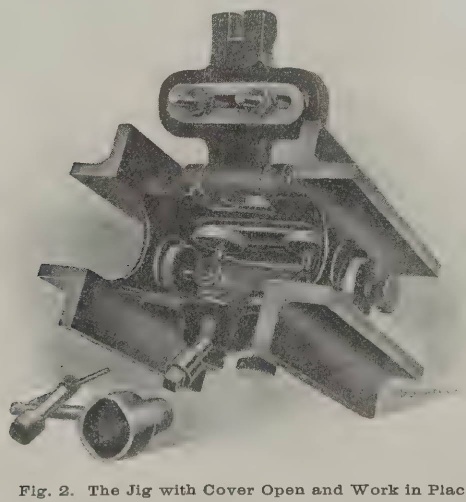


Fig. 2. The Jig with Cover Open and Work in Place.

The line cuts, Figs. 3 and 4, give a good idea of the design of the device. These cuts show two views of the jig as arranged in the halftone, Fig. 2. In Fig. 3, which is a horizontal section viewed from above, *A A A* are locating screws which form the abutment against which the work is clamped in a horizontal plane. These screws are provided with lock nuts and are threaded into bushings *B B B* which are clamped in slots in the side and end of the frame, as shown in the photograph. They are tightened by nuts *C C C*. As shown at *B* in Fig. 4, the holes in the bushings in which stop screws *A* are carried are eccentric, so that vertical and side adjustment for all of screws *A* is possible. Knurled clamped screw

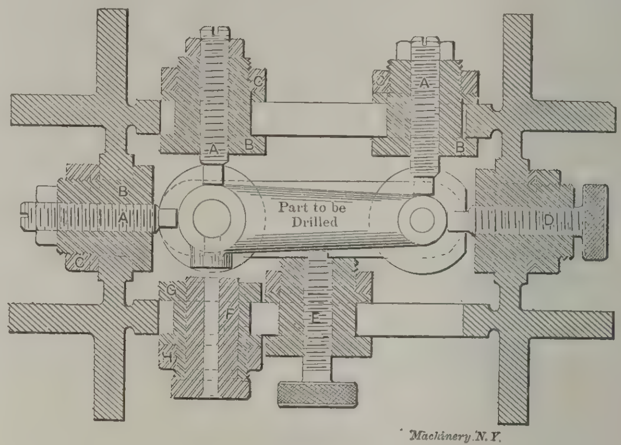


Fig. 3. Horizontal Section through Locating Screws.

D is carried in similar adjustable eccentric bushing in a slot at the other end of the frame. This screw holds the work against the left hand screw *A*, while a similar knurled head thumb screw *E* holds the casting against the back screws *A A*. Slip bushing *F* is carried by clamp bushings *G* and its nut *H* is carried by the front slot. This bushing may be removed to tap the hole after it has been drilled. So much for the holding devices and the jig bushings operating on the work in a horizontal plane. In a vertical plane, as shown in Fig. 4, the work rests on projections on the inner surface of drill bushings, *J J*, which are clamped by means before described in a slot in the body opposite the cover. Thumb screw *D* and stop screw *A* are those shown on the center line of Fig. 3. The cover *K*, which is mounted as shown in Fig. 2, carries in its slot two adjustable set screws *L L* held by lock nuts in the cover slot. The closing

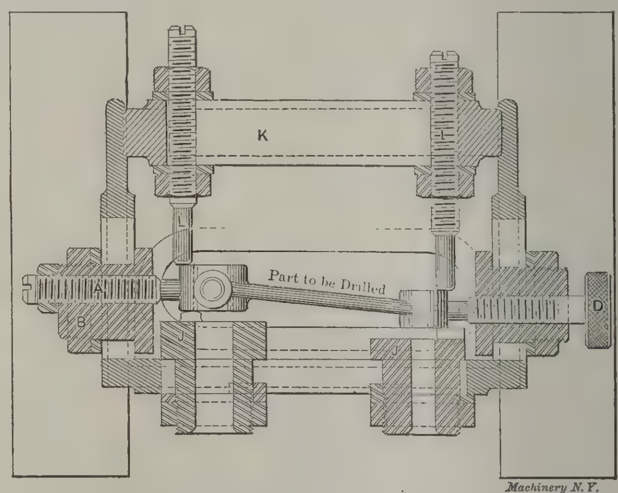


Fig. 4. Vertical Section through Cover Screws and Jig Bushings.

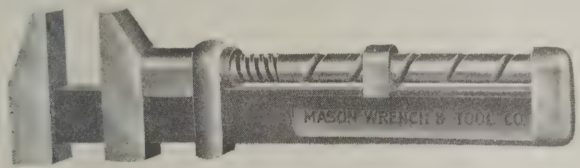
of the cover brings these down as shown on top of the work and the tightening of the cover nut with the key wrench shown in Fig. 1, in combination with the tightening of screws *D* and *E* in Fig. 3, fixes the position of the casting in relation to jig bushings *F* and *J J*. For holding round parts bushings *J J* with V-grooves formed in their inner faces are used.

In setting up the jig for a given piece, the location of the bushings is determined by inserting standard plugs in them, and taking measurements with micrometers or vernier calipers between the plugs themselves, and the surface plate on which the device rests, altering the adjustment until the correct location has been determined. After this has once been done a correctly made piece should be saved as a model; then, when the jig has to be set up again, the work may be placed within it and standard plugs used to bring the bushings in line with the holes in the model. The manufacturers state that this jig is the outgrowth of many years' experience on high grade jig and fixture designing. They call attention to

the ease with which it is adjusted and the accuracy of the work of which it is capable. The work may be placed in the jig and clamped in position as though it were specially designed for that particular piece. The bushings and gage points are all interchangeable. The device is made in eight sizes which will take in a complete range of work from 2 to 15 inches in length.

THE NOYES QUICK-ACTING WRENCH.

The most notable feature of the wrench shown below is the arrangement used for adjusting the jaws. A screw threaded in the jaw is used as usual. This screw, however, has a long body extending the full length of the handle and provided with a spiral groove of steep pitch. The sliding block or nut which engages this groove may be adjusted by hand to any position on the length of the handle. As it is moved its action on the spiral groove rotates the screw, which in turn

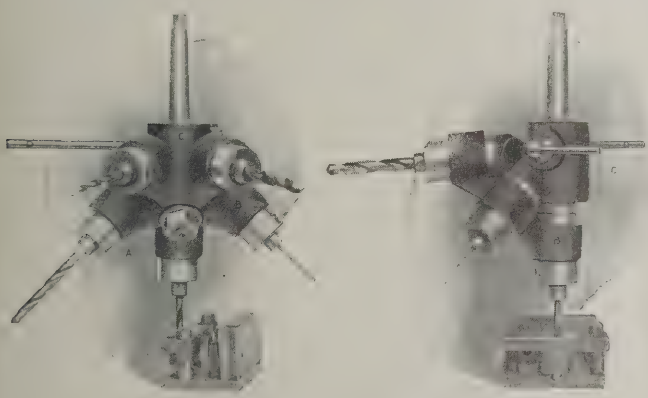


Noyes Quick-acting Wrench.

adjusts the movable jaw of the wrench. The pitches of the groove and the screw are so arranged that the mechanism is self-locking. This action is practically instantaneous since all that it is necessary to do to entirely close or entirely open the wrench is to slide the block from one extremity of its travel to the other. The makers, the Mason Wrench & Tool Co., First National Bank Building, Chicago, Ill., assert that special attention has been given to the strength of the tool, it having been designed to withstand any strain which may come upon it.

THE GEM TURRET HEAD FOR DRILL PRESS OR LATHE.

A five-tool turret head for the drill press or lathe in which only the tool in use revolves, is shown in the accompanying cut. To the inclined stud *A* is pivoted the revolving head *B*, carrying the five chucks for the tools. Handle *C* operates an eccentric which makes the connection between the revolving shank, driven from the spindle, and the tool chuck which is at the time in line with it. In the upper end of the chuck is milled a groove in which a hardened steel pin on the end of



Gem Turret Head for Drill Press or Lathe.

the shank is engaged. A tapered dowel in the center of the shank brings it and the chuck into perfect alignment. The bar *D* prevents the apparatus from turning as a whole.

The body of the turret is of gray iron, the spindle is of steel, the eccentric pin used in engaging the individual drills is of tool steel, suitably tempered. There are no springs or complicated clutch movements, and the drill working at the time is the only one that is in motion. Changes from one tool to another may be made almost instantaneously without stopping the drill press, regardless of the speed at which it is running. It may be applied to the spindle of a lathe for drilling work bolted to the carriage, or it may be held in the tailstock and take the place of a turret in finishing holes in work held in the chuck. This device is made by the Patterson Tool & Supply Co., Dayton, Ohio.

INDUSTRIAL NOTES FROM EUROPE.

Annealing and Hardening Furnace with Electrically Heated Liquid Bath, by L. M. Cohn, Berlin. The author gives a brief description of the processes in steel during annealing and hardening and deducts therefrom the conditions for a good annealing apparatus. Discussing the existing arrangements the author comes to the conclusion, that they by no means meet the requirements. Some afford the danger of changing the percentage of carbon in the steel; the obtaining of a uniform temperature depends to a great extent on the attendants; the temperature cannot be determined with sufficient accuracy; temperatures of up to 1,150 deg. C. (2,102 F.) as required for high-speed tools are only obtainable with one single type of furnace (electric hardening furnace by H. Craens, Hanau, Germany) and even there with difficulty; and temperatures of 1,300 degress C. (2,372 F.) as necessary for special steel tools for wholesale manufacture, and having to be of great strength, cannot be obtained at all.

The new furnace, designed and patented by Messrs. Gebr. Körting, Elektrizitäts G. m. b. H. Berlin, has a liquid bath heated by an electric current passing through it. The temperature of this bath is uniform throughout, except the uppermost layer, which may be considered as a sort of cover. The steel immersed in it is, therefore, heated uniformly in all parts. The temperature can be accurately measured and very easily adjusted to any temperature up to 1,300 degrees C. (2372 F.), and even higher still if required. The heating of the steel requires a comparatively shorter time than in other arrangements; waste or spoiled goods is exceptional; the percentage of carbon is not changed and the working is very economical.

The furnace consists mainly of a cast iron box, which is lined inside with fire-clay. Inside this lining is a second lining of fire-bricks, lined again with asbestos and inclosing the crucible made of one piece of fireproof material. The size of the crucible depends on the purpose the furnace is intended for. Two electrodes lead into the crucible, through which only alternating current has been sent, for avoiding electrolytical effects. The crucible is filled with metal salts, which in a cold state will not let electric current through, but are excellent conductors when molten. A special regulating transformer serves to regulate the current, and thus also the temperature. For temperatures above 1,000 degrees C. pure chloride of barium is used, the melting point of which is at about 950 degrees C. (1,742 F.); for lower temperatures a mixture of chloride of barium and chloride of potassium, 2 to 1 is used, melting at about 670 degrees C. (1238 F.). However, any other suitable salts may be used.

A test was made with a furnace, the bath of which was 6½ x 6½ x 7 inches. A 50-period alternating current of 190-volt primary tension was used. This tension had to be reduced to from 50 to 55 volts by the regulating transformer for starting the furnace, and lowered later on. The heating lasted about half an hour. For temperatures from 750 to 1,300 degrees C., the secondary tension amounted to from 13 to 18 volts. The consumption of energy was as follows:

Temperature in Deg. C.	Consumption of Energy, Kw.
880	5.4
1,140	8.5
1,300	12.25

A milling cutter 5 inches diameter, 1¼ inch bore, 1 inch thick, was heated in 62 seconds to 1,300 degrees C.

Another cutter 4½ inches diameter, 1¼ inch bore, ¾ inch thick, was heated in 55 seconds to 1,300 degrees C.

A bushing of ordinary tool steel 2¾ inches diameter, 2¾ inches long, ⅝ inch bore was heated in 243 seconds to 850 degrees C.

The two cutters had been previously heated in charcoal fire to a dark red heat, but the bushing had not.—*Elektrot. Z.* 1906, No. 31, Aug. 2, p. 721.

Some Grinding Machines exhibited by Naxos Union, Frankfort-on-Maine, at the Bavarian Jubilee and Lands Exhibition, Nuremberg, 1906:

No. 1. Grinder (German patent No. 247,711), with steel disks, covered with emery cloth or paper for accurately grinding small pieces of work.

No. 2. Grinder for edging heavy castings and forgings, plates, rolled iron, etc.; patent elastic, adjustable hinged guard (German patent No. 162,518).

No. 3. Direct electrically driven grinder for working heavy castings and forgings, edging plates, rolled iron, etc.

No. 4 Grinder (German patent No. 237,572) with revolving flexible shaft for grinding curved and molded round articles, which are stuck on the free end of the flexible shaft and thus rotated during work.

No. 5. Grinder with swiveling rest and direct electrical drive for wet grinding of profiled tools.

No. 6. Grinder with magnetic work table for smoothing thin articles, such as piston rings, etc.

No. 7. Grinder with planet-grinding spindle (circular motion of grinding spindle) (German patent No. 160,832), for grinding curved and straight links, grinding out sleeves and bores or large unwieldy parts or truing trunnions on the latter.

No. 8. Automatic twist drill grinder (German patent No. 166,460).

No. 9. Automatic saw grinder for circular and frame saws.

No. 10. Grinder with electrically driven grinding wheel for automatic grinding and polishing rolls.

Sewing Machine Industry.—This line has been very successful, the consequence being that several of the leading firms are contemplating extensions. Baer & Rempel, Bielefeld, have erected new large premises; Hengstenberg & Co., Bielefeld, are about to erect an annex; Dürkopp & Co., Bielefeld, are pushing the manufacture of sewing machines for special purposes; Siedel & Naumann, Dresden, are increasing their plant considerably, having put down a 1,000 horse power steam turbine, and are about to entirely reorganize their entire works; Clemens Müller, Dresden U., has erected a vast new building which he intends equipping next spring with new machine tools.

Electrical Engineering.—A new limited company has been founded as Elektrizitäts Gesellschaft Hochstrate & Böttcher Nachfolger, G. m. b. H., Witten, with the object of manufacturing and selling electrical machines and appliances. The capital invested amounts to $15,000.

Flexible Shafts for Cleaning Boiler Tubes.—Gustav Pickhard, Bonn, on Rhine, advertises his new flexible shafts for cleaning boiler tubes. These shafts consist merely of two or three closely wound wires, which thus form a very flexible, and yet strong spiral cable. These cables or shafts will not kink, and can be inserted to any depth into the boiler tubes. Tube cleaners, scrapers or brushes are attached to their end, and they allow of a great force being applied. They are supplied either in given lengths and then coupled together or they are supplied in one long piece. This causes no inconvenience whatever, as they are not heavy and are readily coiled up to a coil of comparatively small diameter. They vary from ¼ to ¾ inch outside diameter, the steel wires used being from 1-16 to ¼ inch thick. The prices vary from $1.75 to $12.50 per meter.

Suction Gas.—In a paper, "On the Development of Modern Suction Gas Plants," read before a special meeting of the Berlin branch of the Society of German Engineers, Chief Engineer Fritz Schleicher of the Gas Engine Works, Cologne-Deutz mentions a novel use of suction gas. The gas coming from the generator passes through the scrubber and purifier and through a fan producing the necessary action. Behind the fan the gas, which may be now termed pressure gas, is used to heat annealing furnaces, hardening furnaces and for soldering small parts. This novel use has been repeatedly and successfully employed in machine works for case-hardening parts of machines, in bicycles and motor car works, sewing machine works, etc., for hard soldering the various parts.

Iron Works Near Bremen.—A limited company has been formed by notable Bremen and Frankfort firms with a capital of $3,000,000, for preparing the establishment of large iron works. The chief products are to be pig-iron for export and foundry purposes, and steel for shipbuilding.

Grillo, Funko & Co., Gelsenkirchen, Westfalia, have leased a tract of land near the "Consolidation" pit, intending to erect there a plant for the manufacture of boiler tubes.

Berlin, Germany, November 15, 1906. D.

MISCELLANEOUS FOREIGN NOTES.

Craven Brothers, Ltd., Manchester, England, have lately redesigned their line of planers and have introduced two marked improvements in connection with this. On the smaller sizes there is a new cushioning device to prevent shock on reversal in high speed planing, and on the larger sizes there is a new system of main drive where the shifting belts are eliminated, although the drive still remains a belt drive.

A multiple drilling machine of a special design has recently been built by G. Swift, Halifax. It consists of five individual drill presses without tables mounted on a bed-plate 2 feet 6 inches high. The maximum distance between the spindles and the top of the table is 20 inches, the distance between the centers of the various spindles is 24 inches. The spindles are driven by direct gearing and will drill holes up to 1 inch in diameter. The driving arrangement is placed under the table or bed; this latter is 10 feet long by 3 feet wide.

D. Mitchell & Co., Ltd., Keighley, England, have placed on the market a new 4-foot radial drilling and tapping machine. The design is similar to that of ordinary radial drills, but there are some improvements in the driving and back gear arrangements. The drive may be either a 4-step cone driving the machine in the ordinary manner with or without back gears, or the machine may be supplied with a gear box and a single pulley drive. The arm is of pipe section and may be turned around to a complete circle; it is raised and lowered by means of worm gear and rack and pinion. The feeds obtained are 0.017, 0.011 and 0.006 inch per revolution of spindle. The bed of the machine is 2 feet 1 inch deep by 2 feet 3 inches wide and is provided with T-slots on the top and on the sides.

The firm of John Hetherington & Sons, Ltd., Manchester, England, has brought out a new high-speed radial drill. This machine is fitted either with self-contained motor drive or with countershaft drive, and is geared either directly to the spindle or by double or triple back gear arrangement. It is intended for use with high-speed steel drills. The radial arm has an adjustment through an arc of 180 degrees. The spindle has a diameter of 3 inches. The maximum distance from the base-plate to the spindle nose is 6 feet 2 inches, and the minimum distance is 4 feet 2 inches. The length of the radial arm from the center of the trunnion to the outer end is 7 feet 10 inches. The required floor space is 13 feet x 16 feet 3 inches. One smaller and two larger sizes of the same design are built by this firm.

In the first half of the year 1906 Scotland produced an amount of tonnage from her shipyards unprecedented in the history of shipbuilding. In these six months, according to a Glasgow dispatch, the shipyards put into the water no less than 207 vessels of all sizes, with an aggregate tonnage of 360,489. The nearest approach to that record was made in Scotland in 1902, when in six months 259,804 tons were produced. The large output from the Clyde yards was augmented by the launches of the *Lusitania*, a Cunard steamer of 32,500 tons, and the *Agamemnon*, a battleship of 16,500 tons, in the closing weeks of the half year.

The automobile and the motor omnibus have been considered in this country by many as more or less of a superfluous luxury. For this reason it is surprising to realize that the motor omnibus traffic in London reaches proportions far above what we generally conceive of. The motor omnibus in London carries in a year nearly 80,000,000 passengers which is considerably more than half the number of passengers carried by the New York subways. This fact is one of those which indicate the future of the automobile for other than recreation and racing purposes, and the automobile would fill its place and justify its existence far better if developed along such lines of general usefulness than along the lines of an expensive, and in many cases unnecessary, luxury.

SOCIETY FOR PROMOTION OF INDUSTRIAL EDUCATION.

In response to a call issued a month or two ago by a committee formed for the purpose, a party of manufacturers, educators, social workers and others interested in the project gathered at Cooper Union on the afternoon of the 16th of November, when the National Society for the Promotion of Industrial Education was organized and launched on what promises to be a thoroughly useful career. The objects of the society as expressed in the constitution adopted by that meeting are: "To bring to public attention the importance of industrial education as a factor in the industrial and educational development of the United States; to provide opportunities for the study and discussion of the various phases of the problem; to make available the results of experience in the field of industrial education both in this country and abroad; and to promote the establishment of institutions for industrial training."

The following officers were elected: President, Henry L. Pritchett, president of the Massachusetts Institute of Technology; vice-president, M. W. Alexander, General Electric Co., Lynn, Mass.; treasurer, V. Everit Macey, New York City. A board of managers consisting of twenty-seven members was also selected.

In an evening meeting of surprisingly large attendance, President Murray Butler of Columbia University presided, in the absence of President Pritchett, who was detained by ill health. This assemblage, in the crowded main hall of Cooper Union, was addressed by Dr. Butler, Frank G. Vanderlip, of the National City Bank, who spoke on the influence industrial education might play in our trade relations; Frederick P. Fish, president of the American Telephone & Telegraph Co., who discussed its effect upon citizenship; Alfred Moseley, whose speech related to American educational methods in general; Samuel B. Donnelly, secretary of the Building Trades Labor Association, who expressed the sympathy of organized labor with the aims of the new society; and, finally, Miss Jane Addams, of Hull House, Chicago. She dwelt upon the educational and moral side of the movement and expressed the hope that industrial education would lead to a greater satisfaction with life on the part of the workman, than was possible when he considered his work to be only a means of livelihood, without having for him any intrinsic interest.

According to the constitution adopted, all persons interested in industrial education are eligible to membership in any one of the four following classes: Members, paying annual dues of $2; sustaining members, paying annual dues of $25; life members, consisting of those who pay the sum of $250 or more; and honorary members, who are elected to that position by the unanimous vote of the board of directors, on account of having achieved "special distinction in promoting industrial education."

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PERSONAL.

Corneil Ridderhof, treasurer and general manager of the Wilmarth & Morman Co., Grand Rapids, Mich., has sold out his interest in that company. He will remain with the concern for the remainder of the year.

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FRESH FROM THE PRESS.

Annual Report of the State Geologist of New Jersey for the Year 1905. 338 pages, 6 x 9 inches. Illustrated. 3 maps. Copies can be obtained upon request. Address Mr. Henry B. Kummel, State Geologist, Trenton, N. J.

Car Interchange Manual. Booklet form 3½ x 5¾ inches. 223 pages. Published by the McConway & Torley Co., Pittsburg, Pa. Price 25 cents.

This book is a companion of the Catechism of M. C. B. Rules and is devoted to abstract decisions of the Arbitration Committee of the Master Car Builders' Association. It contains abstracts of cases 1 to 703 inclusive. Some miscellaneous matter is added, giving monetary values of wooden cars; tables of words often misspelled on car reports; limits of tire wear for various types of steel-tired wheels, principles of levers, first aid to the injured, etc.

The Mechanical World Pocket Diary and Year Book for 1907. 247 pages (exclusive of advertising). 4 x 6 inches. Published by Emmott & Company, Limited, Manchester, England.

This is a small mechanical handbook, issued annually, containing the useful tables and formulas found in handbooks of this kind. It is particularly complete in regard to steam engineering, nearly 100 pages being given up to this subject. At the end of the book is a calendar for 1907 with more than 50 pages for memoranda. For general use this is a very handy little book well worth its cheap price which is only 25 cents in England, but if ordered from the United States the postage to this country must, of course, be added.

Practical Alternating Currents. By Newton Harrison. 375 pages, 5 x 7½ inches. 172 cuts. Published by W. L. Hedenberg Publishing Co., New York. Price $2.50.

This book is a practical treatise on the principles and application of alternating currents and is written in a delightfully easy style. Mr. Harrison is an author of rare ability in presenting a complex subject in a simple and entertaining manner. We know of no treatment on alternating currents and power transmission so well adapted to the needs of young electricians and others desirous of understanding the principles of the alternating current as this. The book is gotten up in pleasing style, well printed and is altogether a creditable effort in the field of technical publication.

Catechism of the M. C. B. Rules, 1906. Pamphlet form 3¼ x 6 inches, 40 pages. Published by McConway & Torley Co., Pittsburg, Pa.

The booklet is what the title indicates, being a résumé in the form of questions and answers of the important Master Car Builders' rules. It contains a number of illustrations, formulas, etc., and is well worth having by those interested in car construction and maintenance. Copies are sent free on request to those interested.

Machine Design. By Charles L. Griffin. 184 pages, 6 x 8 inches. 82 cuts. Published by the American School of Correspondence, Chicago, Ill. Price $2.00.

This book forms part of the course of instruction in mechanical engineering of the American School of Correspondence and doubtless is one of the best treatises on practical machine design. It was warmly commended in these columns in the first review some years ago. It is strictly in sympathy with actual conditions which the machine designers have to meet, being written by a man well known for his sound mechanical judgment and practical common sense, who was, and is, closely in touch with the conditions surrounding the design and construction of machines. The work is well worth the attention of all machine designers.

Turning and Boring Tapers. By Fred H. Colvin. Pamphlet form, 5½ x 8 inches. 25 pages. 22 cuts. Published by the Derry Collard Co., New York. Price 25 cents.

This booklet is No. 1 of a series of practical papers, and is a copy of the second edition. The determination of tapers and the setting of machines to produce them is a matter of practical importance to shopmen. It perhaps would not be far from the fact to say that there is no one other technical subject that interests a lathesman more than this, and a book which will tell him just how to measure or determine the proper setting for tapers and give him a comprehensive and correct idea of the subject as a whole, is of much intrinsic value. This little work undoubtedly fills the bill.

The Machinist and Toolmaker's Instructor. By Edward Genung. 264 pages, 4 x 6¾ inches, illustrated. Bound in "pocketbook" style with flap Sold by N. H. Covert, Beaver Falls, Pa. Price $3.00.

This book was published by Edward Genung in 1896 and, of course, is not a new book containing all the latest features of toolmaking and mechanical work which have been developed since that time. A great deal of the matter, however, is of a character that is always good and instructive for apprentices, mechanics and others requiring the information contained. The book treats of arithmetic; geometry; screw threads; trigonometrical tables; gearing, including spur, spiral, bevel and worm gearing; milling machines; principles of mechanics; screw-cutting, steel working, etc. Many will doubtless find it of much practical value in their everyday work.

Air Compressors and Blowing Engines. By Chas. H. Innes. 290 pages, 4¾ x 7 inches, 285 cuts. Published in the United States by the D. Van Nostrand Co., New York. Price $2.00.

This book is specially intended for mechanical engineers taking up the theoretical as well as the practical sides of the subject. The first chapter treats of the physical properties of air, following which are chapters on experiments with compressors; valves for producing equalization of pressure; blowing engines; and air compressors. The theoretical chapter on the physical properties of air is of considerable extent, but without use of the higher mathematics. The general descriptive part has reference, of course, to British types of machinery. The illustrations are mostly line cuts and reproductions of wood engravings. These are not very well executed, but the book as a whole is of considerable value to those interested.

Text-Book on the Strength of Materials. By S. E. Slocum and E. L. Hancock. 236 pages, 6 x 9 inches. 170 illustrations. Published by Ginn & Co., Boston, New York and Chicago. Price, $2.00; by mail, $2.15.

The subject matter of this book has been divided into two parts: the first presenting the theoretical side of the strength of materials and the second the experimental side. This was done to provide for the needs of both the classroom and the laboratory. As might be expected, the theoretical side of the subject is rigidly mathematical, using the calculus for the deductions. Part 2, or the experimental part of the book, treats of the properties of iron and steel, lime, cement and concrete, reinforced concrete, brick and building stone, timber, rope, wire and belting. An excellent feature of the mathematical part of the book is the insertion of numerous problems to be worked out by the student. The answers are given in the back of the book.

Marine Engineers; Their Qualifications and Duties. By E. G. Constantine. 332 pages, 4¾ x 7 inches. 84 cuts. Published in the United States by D. Van Nostrand Co., New York. Price $2.00.

As indicated by the title this work is of the practical duties of marine engineers, giving an idea of what the nature of a marine engineer's duties are; what the requirements are as to education and training, term of apprenticeship, etc. The work takes up the history of the marine engine and its development; it treats of boilers and boiler management; and in addition gives copious notes on the Board of Trade examinations which must be passed in Great Britain in order to get an engineer's certificate. The book is interestingly written and presumably reliable in its statements. The work, of course, is strictly British in tone and the technical requirements laid down are those affecting British commerce and do not necessarily apply to the requirements for American marine engineers.

Metallurgy of Cast Iron. By Thomas D. West. 627 pages 4¾ x 7¼. 153 cuts. Published by the Cleveland Printing Co., Cleveland, Ohio, and sold by the David Williams Co., New York City. Price $3.00.

This well-known work now appears in the eleventh edition. The wide sale it has had is an indication of its worth to foundrymen and foundry chemists. The conditions of foundry practice have undergone a great change within the past twenty years; the old-time method of mixing depending on the judgment of the cupola charger has been largely superseded by the more intelligent and reliable practice of charging according to analyses. It is a consummation for which Mr. West has worked diligently, and to his efforts in a large measure, no doubt, is the improvement in present American foundry practice due. The book is a standard treatise on the metallurgy of cast iron and should be in the hands of every practical foundryman who expects to make a success of his business.

CONTENTS FOR DECEMBER.

American Stationary Engineering. By W. E. Crane. 285 pages, 5½ x 7½ inches. 107 cuts and diagrams. Published by the Derry Collard Co., New York. Price $2.00.

This book is intended for the engineer and fireman of power plants and the mechanical engineer as well. It is strictly practical in every respect, containing just such information as many are looking for but which is contained in few available works. The book treats of the boiler room; boiler feeding, pumps for boiler feeding; scale in boilers; boiler cleaning; strainers; strength of boilers; boiler settings and fittings; boiler explosions; taking care of expansion; main steam pipes; steam heating; mason work; making cements; pile driving; brick and steel chimneys; the engine room; balancing engines; lining engines; bushing cylinders. piston rods; hot boxes; Corliss engines; air pumps and condensers; tools for the engine room; belting, horse-power, belts; oils; cleaning; compression lap and lead; steam pumps; safety valve calculations; pop valves; estimating water power; examination questions, etc. It is one of the few books that can be conscientiously recommended to engineers, firemen and others requiring sound instruction on the essential principles and practices of stationary engineering.

NEW TRADE LITERATURE.

Rockford Machine Tool Co., Rockford, Ill. Circular describing and illustrating the 20-inch Rockford shaper.

The Graham Mfg. Co., Providence, R. I. Leaflet describing the Graham drill speeder, telling some things it will do and giving dimensions.

W. F. & John Barnes Co., 231 Ruby St., Rockford, Ill. Catalogue No. 61 treating of upright drills and other machine tools. These machines are illustrated and such description as is necessary is given.

Gisholt Machine Co., 1316 Washington Avenue, Madison, Wis. Leaflet illustrating a method employed by this company for finishing an automobile flywheel.

Joseph Dixon Crucible Co., Jersey City, N. J. Pamphlet of Dixon's motor lubricants. Lists and describes the various graphite lubricants and points out advantages of same.

The Pittsburg Automatic Vise & Tool Co., Pittsburg, Pa. Illustrated catalogue descriptive of the Pittsburg automatic two-way vises, a departure from former vise construction.

The Fairbanks Co., Springfield, Ohio. Catalogue No. 6 of "United States" tool-holders describing new lathe, planer and shaper tools including turning, threading, side, boring and cutting-off tools.

Franklin Mfg. Co., 203 South Geddes St., Syracuse, N. Y. Booklet showing the possibilities of the Franklin die cast process. Illustrations of the different styles of finished castings produced by this die cast method are shown.

The John M. Rogers Works, Gloucester City, N. J. Pamphlet of high-speed reamers containing illustrations and specifications of various types of reamers, all of which are fitted with high-speed steel blades.

Buckeye Engine Co., Salem, O. Catalogue of Buckeye electric blue-printing machine. A complete description of the construction of this machine is given as well as prices of and directions for operating same.

The Cincinnati Ball Crank Co., 1644-46 Central Avenue, Cincinnati, O. Pamphlet illustrating and giving specifications for steel ball crank machine handles, compound rest handles, machine handles and two-ball levers.

Narragansett Machine Co., Providence, R. I. Locker catalogue listing and illustrating their standard sizes of lockers. It is the aim of the company to produce a high grade steel locker, and special care is given to details, as will be seen by the illustrations on pages 4 to 7.

Norton Grinding Co., Worcester, Mass. Catalogue of Norton plain machines for cylindrical grinding. Specifications and excellent half-tone engravings of the different machines are given. Following the introduction are brief descriptions of the various parts of the machines and a list of their points of superiority.

Waterbury Farrel Foundry & Machine Co., Waterbury, Conn. Catalogue Section A describing "cold process" automatic nut bolt rivet machinery. The several styles of headers have been improved and redesigned throughout and now possess greater strength, durability, speed, ease of operation and adjustment.

Hammacher, Schlemmer & Co., 4th Avenue and 13th Street, New York. Catalogue No. 310 on high-grade woodworking tools in sets. This includes tool outfits for home use as well as for the trades. The special feature of these outfits is the quality of the tools, only those of high grade being included. Price lists and illustrations of several of the outfits are given.

L. H. Gilmer & Co., Philadelphia, Pa. Report of test made of Gilmer endless belts at the Springfield Armory. The test demonstrated that the Gilmer endless belt is superior to leather belts for use on machines having pulleys of small diameter inasmuch as it is less liable to stretch, is light and the joint is of the same thickness as the remainder of the belt.

Ingersoll-Rand Co., 11 Broadway, New York. Bulletin No. 2008, Imperial hoists and stationary motors, gives a complete description of the Imperial motor hoist with illustrations and tables of sizes and dimensions. The Imperial stationary motor, also described, is a small motor of the standard Imperial type designed for all purposes requiring a small but powerful engine for intermittent service. Illustrated part lists of each machine are also included. Bulletin No. 2011, the "Little Jap" hammer drill discusses fully the construction, operation and advantages of this tool.

Joseph Dixon Crucible Co., Jersey City, N. J. The tenth edition of "Graphite as a Lubricant. The subject of lubrication in general, and graphite lubrication in particular, is exhaustively treated. All the good features of the previous edition are retained, but the very latest information—both scientific and practical—that has to do with the subject is added, making it valuable to the student of theory and the man of practice. The publication is arranged and indexed so as to readily enable the reader to find the information he is most interested in. Those who desire to post themselves on better lubrication should secure a copy.

The Western Electric Co., Chicago, Ill. Booklet entitled "Hawthorne Works," being a general description of the Western Electric Co.'s plant at Hawthorne, Ill., which was described in Machinery, for July, 1906. This plant is erected at the extreme west of the city of Chicago, a tract of 110 acres having been purchased five years ago for it and to which more land has since been added. The plant is modern in every respect. The machine shop is 860 feet long, 130 feet wide and is equipped with up-to-date tools for the manufacture of electrical apparatus. The company put special stress on the fact that they are in position to build heavy electrical apparatus and have all the facilities for such work.

The Cincinnati Milling Machine Co., Cincinnati, Ohio. "Examples of Rapid Milling," being an illustrated pamphlet containing sixty illustrations of work done on the Cincinnati milling machine, taken from actual practice. Each example is a half-tone illustration showing the work, the machine, cutters and fixture or jig used for holding the work. One page is given up to each example and data are given, showing the nature of the job, size of cutter, speed in revolutions per minute, surface speed and feed. The pamphlet is a valuable contribution to technical literature, giving data on milling machine production of much value. Needless to say it is an effective argument for the milling machine on the class of work illustrated.

The American Locomotive Co., 111 Broadway, New York, have just published a pamphlet "Consolidation Type Freight Locomotives" describing consolidation locomotives weighing more than 175,000 pounds. It is a companion to the one issued in October presenting the design of this type weighing less than 175,000 pounds. Twenty-eight consolidation locomotives built for various railroads and ranging from 175,000 pounds to 250,000 pounds are illustrated and the principal dimensions of each given. The series now covers the Atlantic, Pacific and Consolidation types and copies of any or all of these pamphlets will be sent upon request.

B. F. Sturtevant Co., Hyde Park, Mass. Catalogue No. 140 on Sturtevant high-pressure blowers. This catalogue is one of the Sturtevant engineering series, and is gotten up with a view of not only advertising the Sturtevant high-pressure blower, but of also presenting engineering data of value on the movement of air by blowers. It describes in detail the Sturtevant high-pressure blower which was described in the February, 1906, issue of Machinery and gives data on diameters of blast pipes, data of value to foundrymen regarding the composition of pig-iron, composition of resulting iron, etc. It also gives a chapter on the construction of the Sturtevant vertical engine. The concluding chapter on testing blowers is of much technical interest and value, giving formulas for determining the volume of air and tables and diagrams determining the weight per cubic foot of dry air under different pressures and temperatures, the flow of air through orifices, etc. It is altogether a most attractive, interesting and valuable catalogue.

The Committee of Manufacturers, 21 William Street, New York City, has sent us a copy of regulations No. 30 U. S. Internal Revenue, entitled "Regulations and Instructions concerning Denatured Alcohol." The law passed by Congress last winter relieving properly denatured alcohol of the internal revenue tax opens up a large field for its use in the arts, and the regulations and instructions concerning denaturing alcohol are of importance to those who intend to enter into manufacture requiring its use. A completely denatured alcohol consists of 100 parts ethyl or grain alcohol (not less than 180 degrees proof or 90 per cent pure), 10 parts methyl or wood alcohol, and ½ part of benzine. Other denaturing substances for alcohol users who cannot use a mixture of grain and wood alcohol, will be taken up in the near future by the Internal Revenue Bureau. The spirit of the law was to render the preparation of denatured alcohol cheap, but the restrictions surrounding it seem to us to favor a distillery trust and to tend in a measure to defeat the aim. However, the matter is a difficult one to handle, and perhaps the prescribed Government regulations are all strictly necessary.

RAILWAY MACHINERY.

A special edition of MACHINERY devoted to Locomotive and Car Equipment and Mechanics.

January, 1907.

FOUR-CYLINDER BALANCED ENGINE RAILWAY MOTOR CAR.

CHARLES R. KING.

A new type of engine for self-propelled railway car has been designed and built for the trunk line services of the Bavarian State Railways by the firm of J. A. Maffëi at Munich, Bavaria. Its peculiarity consists in the complete elimination of the disturbances due to the alternate push and pull on the crank-pins common in all engine arrangements in vogue at the present, which disturbances communicated to the car frame are apt to be very unpleasant to the passengers when the engine is working hard—the pounding on the crank-pins then being such as to give electrical transmission the preference for self-propelled vehicles on railways.

By introducing the steam between two pistons, or simultaneously on their two outside surfaces so that they always travel in opposite directions, the thrusts on the engine frames are completely equalized. In the new Maffëi engine this is done by means of two pistons working in practically one cylinder, the main-rods of each pair of pistons being con-

Fig. 1. Four-cylinder Balanced Engine and Turgan Water-tube Boiler.

Fig. 2. Balanced Engine Motor Car for Bavarian State Railways.

nected to a different driving axle so that all motor efforts are absolutely balanced. At first sight this may seem a trifling consideration, but it is by no means ignored by those who are interested in electrical propulsion and whose claims must be met if steam is to survive in the struggle between the two. The mechanical details of this new engine have been worked out with admirable skill, and the drawings here reproduced will be found to be very instructive.

The half-tone, Fig. 1, shows the boiler, which is of the Turgan water-tube type much employed in France for heavy road motor cars. A superheater (Schmidt type) is fitted to the boiler. The sills of the car are supported on brackets bolted to the cylinder casting at the height of the piston valve chests. This is shown in the cross section but is more clearly understood from the photograph of the motor. The side movements of the frame upon these brackets are flexibly controlled by plate springs, with small bumpers affixed, and aligned longitudinally above the cylinder casting.

The cylinder valves are of the piston type. There is one for each of the four cylinders, the two valves being screwed to the same spindle above the same pair of cylinders. The forward valve is double-ended and the rearward valve single-ended; this arrangement is best described by the cut, Fig. 3 (longitudinal section). The valves are driven from single eccentrics on the rear axle. The valve gear is of the usual Walschaerts or Heusinger type, but the lead-lever is in this case, not connected to a cross-head pin, a feature which is worth copying where great accuracy in the distribution is desirable. The main-rods drive on the crank-pins close up to the wheel face. The pins carry heavy cranks for the side-rods which are provided in order to insure the due position of all engine cranks. The side-rods are situated at sufficient distance from the wheel faces to just clear the outsides of the cylinders. The main-rods have "Y little-ends" of strap pattern with double gibs, and cotter for adjustments; the big

ends being of fork pattern so that the main rods can be taken down readily. Each end of the cylinders as well as their centers are provided with relief pressure and suction valves; and although a Schmidt superheater is employed the usual cocks for the drainage of the cylinders are fitted. The plunger for the boiler pump is fitted at the front extremity of the valve stem. The motorman's platform is situated at the front end of the car which has to be turned at the terminus station. There is, of course, only one attendant; the stoking is automatic as the coal is carried in a hopper on the front of the boiler (firebox end) from which it falls by gravity onto the fire. All the usual gages and levers necessary for the running control of the engine are grouped under the attendant's hands in front of the driving platform.

The Maffëi engines with Turgan water-tube boilers and superheater weigh 1,760 pounds less than the same powered engines with ordinary locomotive-type boiler and superheater. Both classes of motor have been found to be very economical in working. They are designed for all speeds up to 47 miles per hour. The same Maffëi balanced engine is applied to small light-service tank locomotives of the Bavarian State with the single difference that the coupling rods are placed inside of the engine frames.

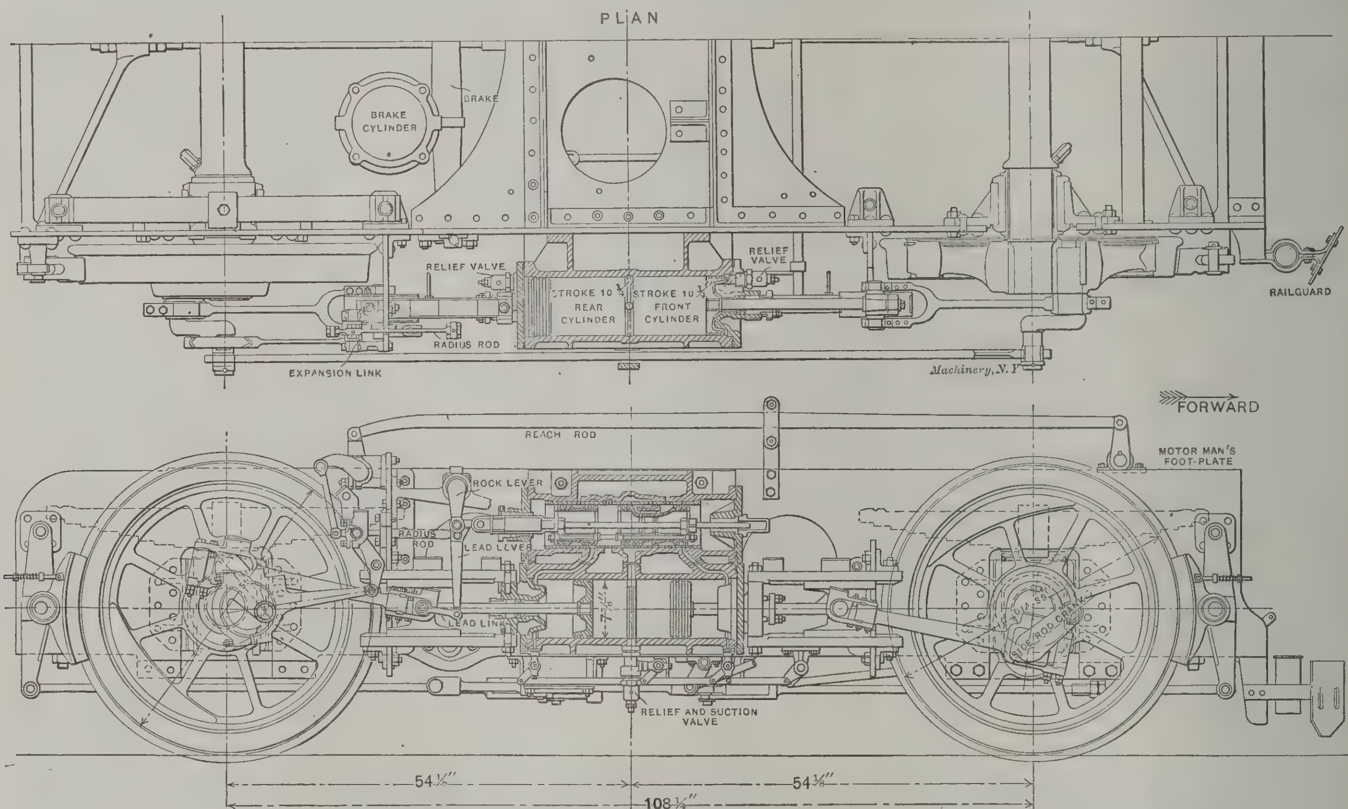


Fig. 3. Half-plan and Sectional Side Elevation of Four-cylinder Balanced Engine and Truck.

MOTOR.

Cylinders, diameter	7⅞ inches
Piston stroke	10¼ inches
Driving wheels, diameter	39 inches
Boiler pressure	135 pounds
Tractive power	3,700 pounds
Grate area	8.9 square feet
Heating surfaces of water tubes in contact with fire	456 square feet
Superheating surfaces	79.6 square feet
Total heating surfaces	535.6 square feet
Weight empty	15.75 metric tons
Weight loaded	17.40 metric tons
Water tank capacity	8,800 pounds
Coal bunker capacity	1,300 pounds
Wheel base of motor	108¼ inches
Minimum radius of curves	590 feet

CAR

Seating capacity	55
Baggage room	59 square feet
Truck wheels, diameter	39 inches
Truck wheels, wheel base	98.4 inches
Total wheel-base of car	51.5 feet
Total length of car over all	65.6 feet
Weight of motor car, empty	45.9 metric tons
Weight of motor car in working order	51.5 metric tons
Weight of trailer car	40 metric tons

COUNTERBALANCING LOCOMOTIVE DRIVERS.

W. M. H.

While working as a machinist in various locomotive repair shops I have seldom met with journeymen who are so well acquainted with locomotive counterbalancing as to confidently undertake the counterbalancing of a set of driving wheels. The practice mostly met with has been to assume that the correct weights have been supplied by the office or drawing department, and to let the wheel men merely apply these weights to the wheels.

However, it is very pleasing to find an interest manifested in this subject by many of the more progressive machinists and apprentices, and I know of no other mechanical subject more eagerly discussed by these than counterbalancing. Seeing so little that is of practical value to the average machinist in the shop published in the mechanical journals on this subject, prompts me to submit both the method adopted by a road I formerly worked for and the actual figures used in applying the method to an eight-wheel (four-wheel connected) engine reported as being out of balance. I also show half-tones (Figs. 1 and 2) of the method used in weighing the wheels and rods, as some may not even understand how this is done. There may be other methods used but the results obtained from the one submitted has proved most satisfactory indeed.

The manner of leveling the wheels, it will be noted, is by the use of the adjusting screws at the bottom of the iron trestles. The straight-edge used has the offset so that the crank-pin does not interfere. One main-rod is also shown on the floor ready for weighing.

Method for Counterbalancing Eight-wheel (4–4–0) Locomotive Driving Wheels.

The revolving weights to be considered are crank-pin hub, crank-pins complete with washers, nuts and cotters, side-rods complete with strap bolts, nuts, keys, set-screws, brasses, liners and oil-cups.

The reciprocating weights to be considered are the piston complete with follower, bull- and packing-rings, liners, bolts and piston-rods, crosshead complete with gibs, oil-cup, wrist-pin, nuts, washers, piston-rod keys and cotters, front end of main-rod complete with brasses, strap keys, bolts, nuts and oil cups.

To find the center of gravity of the counterbalance, make a thin wood or plate templet of the same shape and area as the entire counterbalance block area; suspend this templet from

various points near its several edges and note where the plumbed lines, made from the same points of suspension, intersect on the surface of the templet, when the latter is suspended in the different positions. The intersection of these lines will be the center of gravity of the counterbalance block, provided it is of the same thickness throughout.

To Weigh the Rods.

To weigh the side-rods, level the rods to be weighed on suitable knife-edge supports placed centrally through the crank-pin opening, putting all the parts of the rod which go to make the revolving weight, in the proper places and block up under the supports so that each block may be removed in turn and the weight resting on the support indicated on the weigh scales. The weight so taken, less the weight of the support, will be the weight of the rod on that crank-pin. To weigh the main-rods, weigh each end of the main-rod in the same manner as for the side-rods.

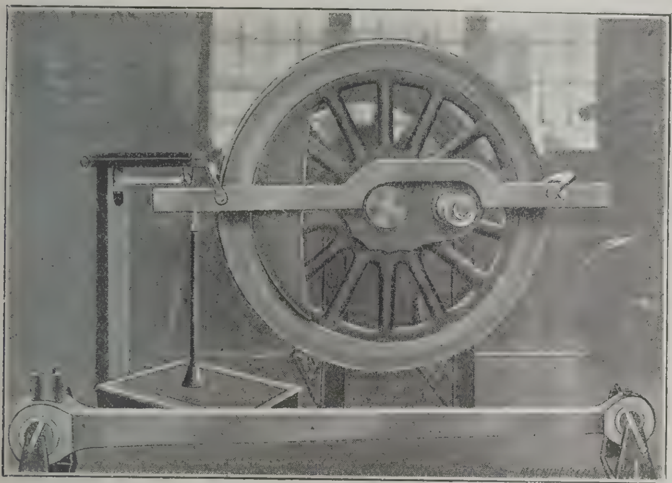


Fig. 1. Weighing the Main-rod and the Counterbalance.

Distribution of the Reciprocating Weight.

Two-thirds of the total reciprocating weight belonging to each side will be the proportion to be balanced in the wheels on that side. Each wheel will be balanced for all of its revolving weight and its proportion of the two-thirds of the reciprocating weight. The portion of the reciprocating weight to be balanced will be divided between the main and rear wheels in proportion to the revolving weight to be carried by each crank-pin.

The Revolving Weight to be Carried by the Main Crank-pin.

The revolving weight to be carried by the main crank-pin will be the front end of the side-rod and the back end of the main-rod. The revolving weight to be carried by the rear crank-pin will be the back end of the side-rod.

Rule for Working Out the Required Weight to be Put On.

1. Find the weight of the main-rod, side-rod and the reciprocating parts.

2. Find the proportion of the two-thirds part of the reciprocating parts to be carried by each wheel. To do this multiply the revolving weight on the front wheel by the two-thirds part of the reciprocating weight and divide by the total revolving weight of both wheels, and the quotient will be the proportion of the reciprocating weight to be divided which is to be carried by the front wheel; subtract the quotient from two-thirds of the reciprocating weight and this remainder will be the proportion of the reciprocating weight to be put on the back wheels.

3. To find the weight required at a radial distance of 36 inches on the front wheel, add the revolving weight on the front wheel to its proportion of the reciprocating weight and divide the sum by 3 (for 12-inch cranks) and the quotient will be the weight required at 36 inches; then subtract the weight already in the wheel from this result and multiply the remainder by 3 and that product by 12, the crank-pin distance, and divide by the distance to the center of gravity and the quotient will be the amount to be put on at center of gravity.

To Find the Correct Amount of Counterweight.

The wheels to be counterbalanced must be on the axles and have the crank-pins, with washers, nuts and cotters applied. Place the wheels with the journals resting on suitable trestles and level up in each direction. Clamp a straightedge on the wheel to be worked on, in line with the crank-pin and axle centers. Then at a point on the counterbalance side, exactly three times the length of the crank-pin radius from the center of the axle, place a perpendicular support to rest on the scales; when the straightedge has been leveled this weight less the support will give the weight already in the wheel at 3 times the crank-pin distance.

Applying the Formula to an Actual Case.

Engine No. 114 was sent in to the shop as being out of balance, and orders were given to have the wheels weighed up and made correct. The crank-pins of this engine were 12 inches from the center of the axle, and the wheels shown in the half-tones are being weighed at a point 36 inches from the center of axle. It does not matter what distance they are weighed at, so long as this distance is taken into consideration when making the calculations. I will now give the exact figures used in doing this work. The reciprocating weights were:

Front (crosshead) end of main-rod....	203.5	pounds
Crosshead complete	259	pounds
Piston complete	328	pounds
Total	790.5	pounds

Two-thirds of which = 527 pounds.

The revolving weights on the front wheel were:

One end of side-rod..................	143.5	pounds
Back (crank-pin) end of main-rod....	358.5	pounds
Total	502	pounds

The revolving weight on the front wheel multiplied by two-thirds of the reciprocating weight is $502 \times 527 = 264{,}554$; dividing by the total revolving weight on both wheels, which for the front wheel is 502 and for the back wheel (one end of side-rod) is $143.5 = 645.5$ pounds we have $264{,}554 \div 645.5 = 409.8$ pounds, the reciprocating weight to be counterbalanced in the front wheel.

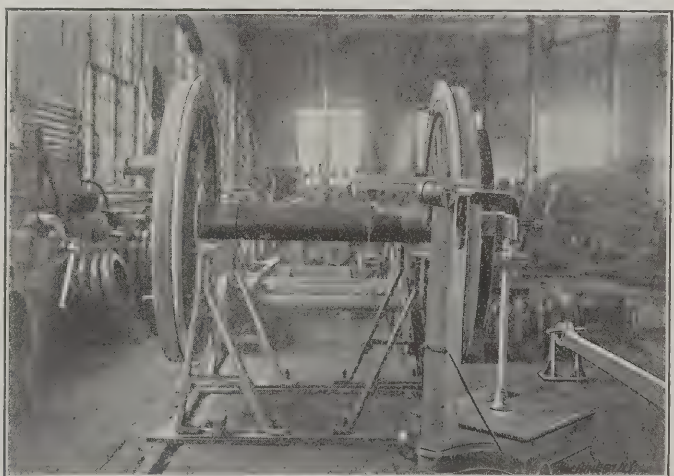


Fig. 2. Weighing the Main-rod and the Counterbalance.

Subtracting this reciprocating weight to be counterbalanced from two-thirds of the reciprocating weight we get $527 - 409.8 = 117.2$ pounds reciprocating weight to be counterbalanced in the back wheel; adding the revolving weight on the front wheel to the reciprocating weight or $502 + 409.8 = 911.8$; divide this by 3 and the quotient 303.9 pounds will be the weight required at 36 inches from the axle center.

Taking 107.5 the weight already in the wheel at 36 inches from 303.9 will give us 196.4 *light* at 36 inches radius; this multiplied by $3 = 589.2$, and again by 12 gives 70,604; divided by the distance to the center of gravity which is 20 inches the quotient is 353.4 pounds *light* or the amount that has to be added to each front wheel at the center of gravity.

The weights to be considered in the back wheel were:

Reciprocating weight	117.2 pounds
Revolving weight one end of side-rod..	143.5 pounds
Total	260.7 pounds

This total weight divided by $3 = 86.9$ pounds, the required weight at 36 inches; subtracting the weight already in the wheel which was 37 pounds, as shown by the scales, $86.9 - 37 = 49.9$ pounds at 36 inches; this multiplied by 3 and 12 and divided by 20, the distance of the center of gravity from the center of the axle, gives the weight required to be applied at the center of gravity, or 89.8 pounds required weight to be added to each rear wheel.

For practical purposes the decimal figures could be discarded but I put them in as I promised to give the actual figures used on the job. It will be seen that this engine was badly out of balance. It has now been running several years, and when I left the service of that company it was giving good satisfaction. If I have not made the subject clear to all interested I would be pleased to give further explanations, but I feel that some at least will be able to follow my somewhat rambling description of locomotive counterbalancing as it was carried out some years ago.

[It should be remembered that where the author speaks of multiplying the revolving weight on each wheel by two-thirds of the total reciprocating weight, and dividing the product by the total revolving weight that it is so worded in order to express a proportion. Of course, strictly speaking, pounds cannot be multiplied by pounds, but what is done is to obtain that fractional part of the total reciprocating weight represented by the individual revolving weight divided by the total revolving weight. Expressed as a proportion we have:

$w : W = r : R$

in which w = revolving weight in individual wheel,

W = total revolving weight in both wheels,

r = part of reciprocating weight to be counterbalanced in individual wheels,

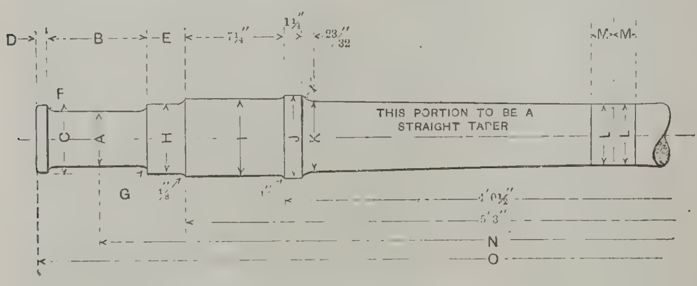
R = 2/3 total reciprocating weight.

Then $r = \dfrac{wR}{W}$. —EDITOR.]

* * *

DIMENSIONS AND CAPACITIES OF STANDARD M. C. B. AXLES.

The accompanying cut and table supplied by Mr. J. C. Hassett, Meadville, Pa., gives the dimensions and capacities of the standard M. C. B. axles, in convenient form. Its chief feature



3¾" X 7" AXLE DESIGNED TO CARRY 15000 LBS.
4¼" X 8" " " " " 22000 "
5" X 9" " " " " 31000 "
5½" X 10" " " " " 38000 "

SIZE	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
3¾" x 7"	3¾"	7"	4¾"	⅝"	2¼"	¼"	½"	4¾"	5⅛"	5½"	4⅞"	4¼"	1½"	6'3"	6'11¼"
4¼" x 8"	4¼"	8"	5¼"	⅝"	2"	¼"	⅝"	5¼"	5¾"	6⅛"	5 7/16"	4¾"	1½"	6'8"	7'0¼"
5" x 9"	5"	9"	6⅛"	¾"	2"	⅛"	¾"	6⅛"	6½"	6⅞"	6 3/16"	5⅜"	1½"	6'4"	7'2½"
5½" x 10"	5½"	10"	6⅝"	¾"	2"	⅛"	¾"	6⅝"	7"	7⅜"	6¾"	5⅞"	3"	6'5"	7'4½"

Machinery, N.Y.

is its conciseness, all the dimensions for each axle being given in the table, reference letters indicating the location of each dimension for the four sizes. For example, the diameters of the wheel fit are found in column I, being 5⅛, 5¾, 6½ and 7 inches respectively, and so on.

PACIFIC TYPE (4–6–2) LOCOMOTIVE FOR NATIONAL RAILWAY OF MEXICO.

An order of five Pacific type locomotives has recently been completed at the Schenectady works of the American Locomotive Company for the National Railway of Mexico. These are the first of their type to go into service on this road, up to the present time the ten-wheeler having been used in handling their passenger traffic. The order consists of three different classes, as follows: three simple engines with Richardson

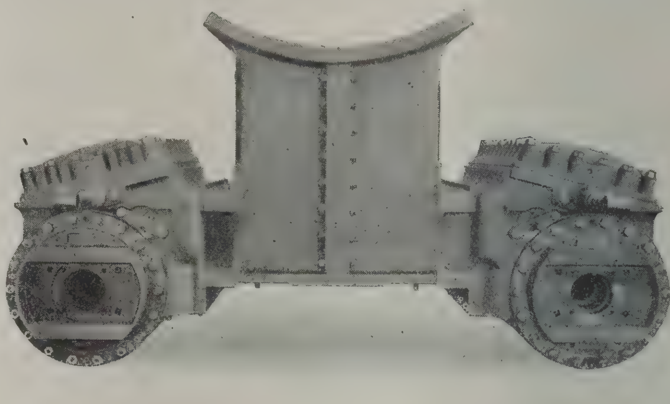


Fig. 1. End View of Pair of Typical Allfree-Hubbell Cylinders.

slide valve, one with Allfree-Hubbell valves and cylinders, and one Cole four-cylinder balanced compound engine with Walschaerts valve gear. As these three classes are of the same specifications except for the difference in cylinders and valve gear an exceptional opportunity is afforded for comparison between them as regards cost of maintenance and operation.

The cylinders of the two classes of simple engines are 22 inches in diameter by 28 inches stroke, and except for the differences in the design of the cylinders and valves the two classes are identical.

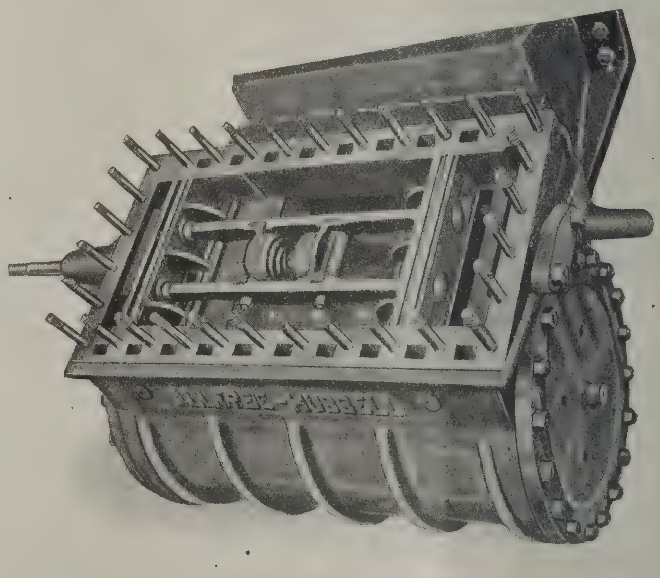


Fig. 2. Side View of Typical Allfree-Hubbell Cylinder with Steam-chest Cover Removed.

The principal features of the Allfree-Hubbell design are that the point of both exhaust opening and closure occurs later in the stroke for all points of cut-off and the amount of cylinder clearance is reduced from 8 per cent and over, as in the ordinary design of cylinder, to about 2½ per cent.

The main steam valve is very long and has inside admission and the delayed exhaust opening is obtained by giving it about 7/16 inch exhaust lap. The delayed exhaust closure is effected by means of compression controlling valves. These are piston valves located in the wall between the steam port and exhaust passage and are operated by a dash-pot connection with the main steam valve. This connection is so arranged that the compression controlling valves open simultaneously with the exhaust edge of the main steam valves but do not close until the main valve has covered about 1¼ inch of the exhaust steam ports. They thus serve the double purpose of delaying the closure of the exhaust until about

90 per cent of the stroke has been completed in short cut-offs and increasing the area of the exhaust opening, thereby allowing the cylinders to quickly free themselves. The reduction of cylinder clearance is effected by means of very short steam ports opening directly into the ends of the cylinders and by less space between the valve seat and the cylinder than in the ordinary design, the top wall of the cylinder in the Allfree-Hubbell design being the bottom wall of the steam chest. The steam chest cover, which also acts as a balance plate to the valve, and is in reality the exhaust chest, is cored out in such a manner that the exhaust passage is passenger and freight locomotives on several roads of the country.

The Cole four-cylinder balanced compound engine is the second instance of the application of this system of compounding to the Pacific type. The first Pacific type engines with this arrangement of cylinders were built for the Northern Pacific Railway. These engines were illustrated in RAILWAY MACHINERY June 1904 and December 1906, and the particular features of this system of compounding fully described, so that it is not necessary in this article to go into a detailed description of the design.

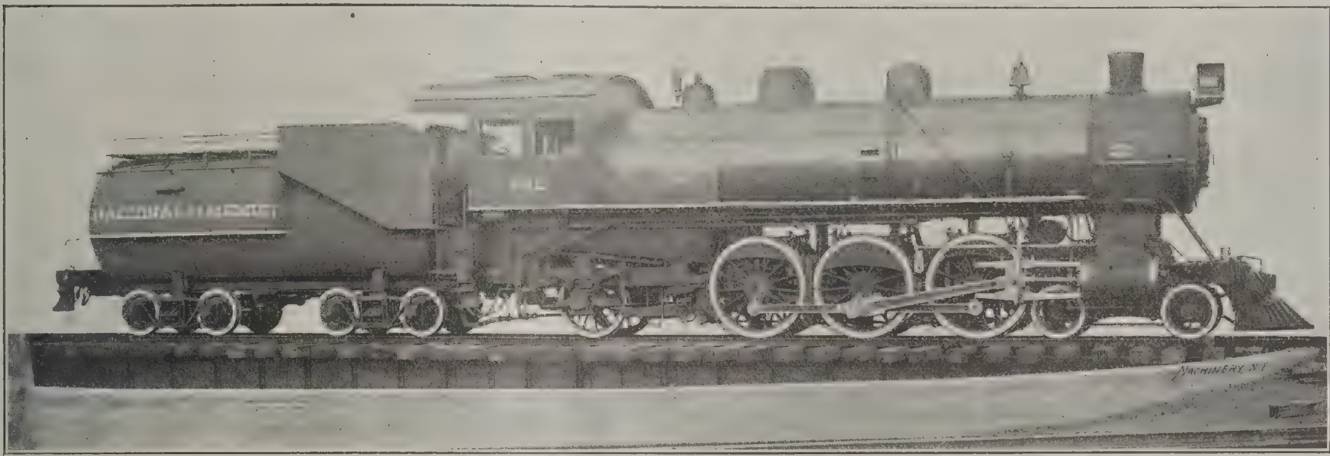


Fig. 3. Simple Slide-valve, Pacific Type Locomotive, National Railway of Mexico.

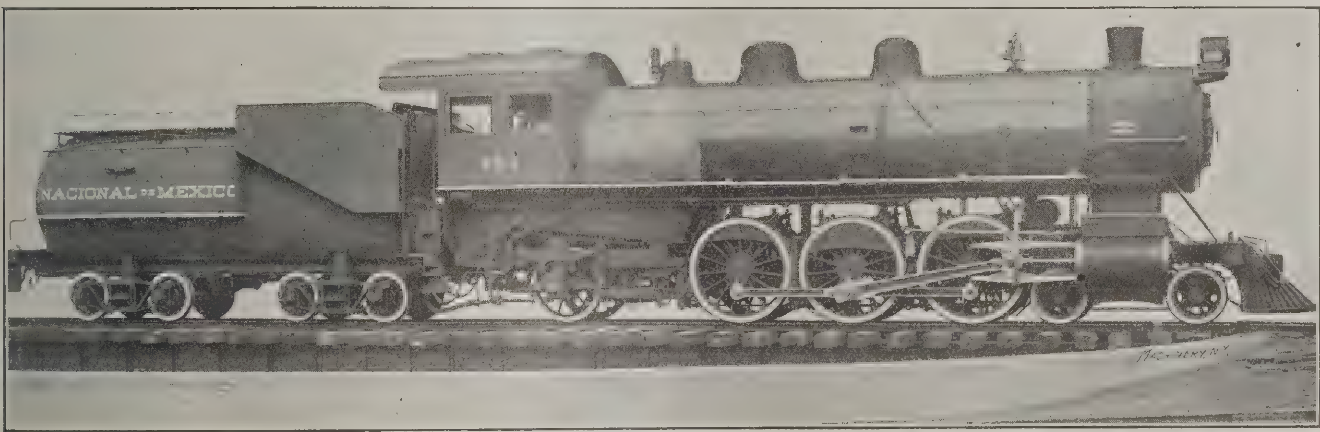


Fig. 4. Allfree-Hubbell Valve Gear, Pacific Type Locomotive, National Railway of Mexico.

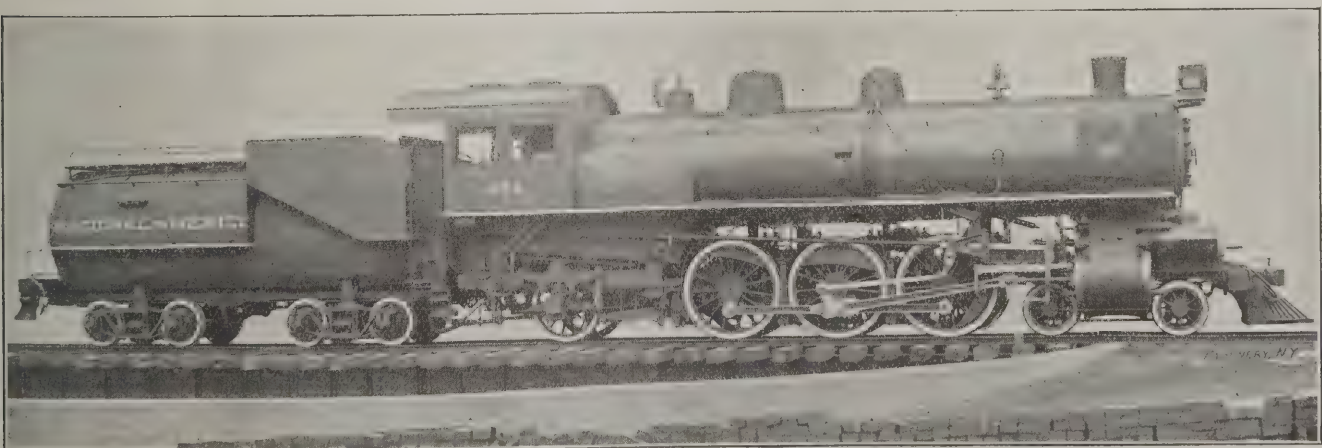


Fig. 5. Cole Balanced Compound Locomotive, Pacific Type, National Railway of Mexico.

insulated from the live steam surface by a dead air space. As the valves have inside admission, the exhaust steam is thus conveyed from the ends of the exhaust chest without coming in contact with the walls of the cylinder or valve chamber, while the live steam forms a jacket over about one-third of the cylinder from port to port. Although to the best of our knowledge this is the first instance in which the Allfree-Hubbell design has been applied to the Pacific type, this system of steam distribution has been tried in other types of both

The modifications in the design necessitated by the application of the balanced and divided principle are chiefly as follows: In order to provide a good length of high-pressure main-rod the cylinders have been moved 12 inches ahead and the forward pair of driving-wheels have been moved back 3 inches, thereby increasing the distance between the forward driving-wheels and the center of the cylinders 15 inches. The boiler is practically identical in design with that of the simple engine except for an increase of 12 inches in the length of

the front barrel sheet as a result of the cylinders having been moved ahead that amount. The important feature of this design in which it differs from the Northern Pacific engines and all other previous Cole balanced compounds is that the high- and low-pressure cylinders have different lengths of stroke. The stroke of the high-pressure cylinders is 26 inches, while that of the low-pressure is 28 inches. This results in making the angularity of the high- and low-pressure rods more nearly equal.

A table of comparison between the principal dimensions and ratios of this design and the Northern Pacific engines is given.

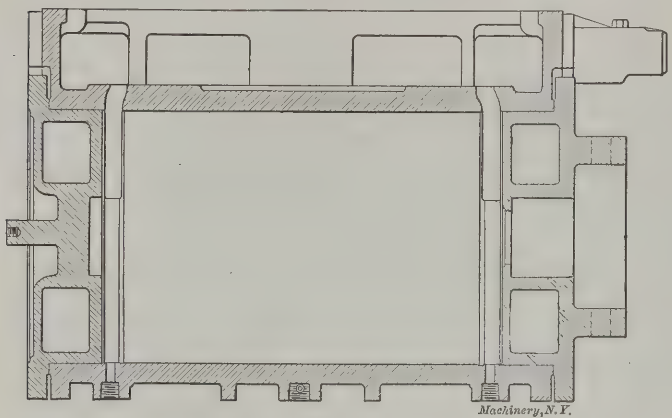


Fig. 6. Longitudinal Section, Allfree-Hubbell Cylinder. Note the Short Steam Ports.

	N. R. of Mexico.	N. P. Railway.
Total weight	241,000	240,000
Weight on drivers	150,000	157,000
Size of cylinders	16½x26 and 27x28	16½ and 27½x26
Diameter of drivers	67	69
Steam pressure	220	220
Tractive effort compound	31,900	30,340
Total heating surface	3798.3	2908
Firebox heating surface	210.3	241.8
Length of tubes	20 feet	16 feet 9 inches
Diameter of tubes	2¼ inches	2 inches
Grate area	51.6	43.5
Weight on Drivers / Tractive Effort	4.71	5.18
Total Weight / Total Heating Surface	63.5	82.5
Tractive Ef. x Dia. Drivers / Total Heating Surface	564	720
Vol. Equivalent Simple Cyls.	10.40	9.9
Total Heating Surface / Vol. Equivalent Cyls.	364	294
Grate Area / Vol. Equivalent Cyls.	4.95	4.3

* * *

HEAVY MALLET ARTICULATED COMPOUND FOR ERIE RAILROAD.

The Erie Railroad has placed an order with the American Locomotive Company for three Mallet articulated compounds, for freight service on their Susquehanna division. The satisfactory service of the Mallet articulated compound, built by this company for the Baltimore & Ohio Railroad, has proved the advantages of this type for service under most difficult grade and curvature conditions, and it is to meet such conditions that the Erie has ordered these three engines. In weight and hauling capacity, however, these engines will greatly exceed the one on the Baltimore & Ohio, or the latest example in this country of this type of locomotive, the Great Northern engines built by the Baldwin Locomotive Works, which were recently illustrated and described.

The proposed design, which is here illustrated, is for an

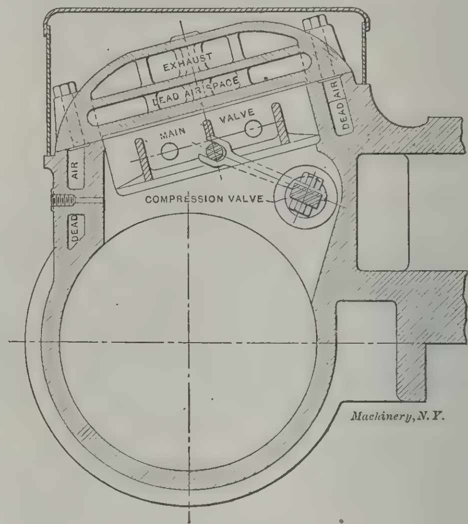


Fig. 7. Cross-section, Allfree-Hubbell Cylinder, showing Compression Controlling Valve.

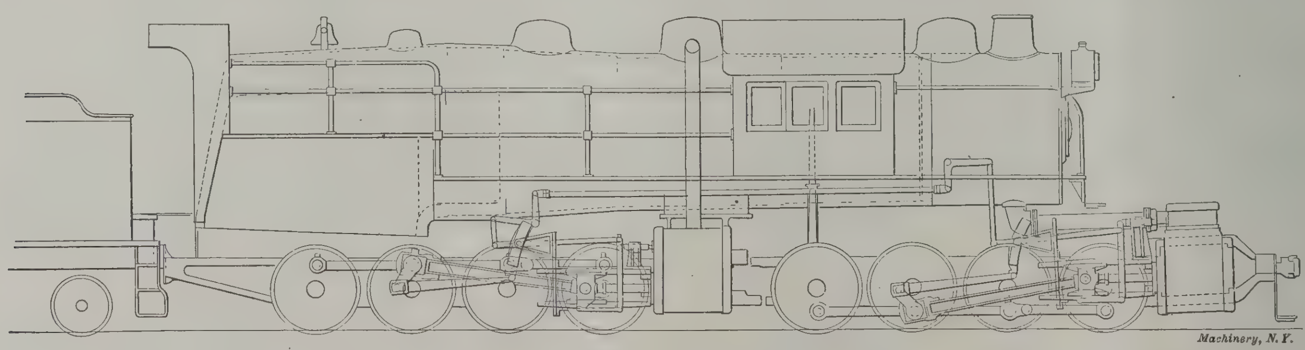
engine weighing 410,000 pounds, with a tractive effort of 98,000 pounds. As the design of these engines is in the preliminary stage, very little can be given in regard to the details at this time, but a comparison of the principal dimensions with the Baltimore & Ohio and the Great Northern engines will be of interest.

Road.	B. & O.	Great Northern.	Erie.
Builder	Amer. L. Co.	Baldwin	Amer. Loco. Co.
Wheels	0—6—6—0	2—6—6—2	0—8—8—0
Total weight, lbs.	334,500	355,000	410,000 (est.)
Weight on drivers, lbs.	334,500	316,000	410,000 (est.)
Size of cylinders	20"&32"x32"	21½"&33"x32"	25"&39"x28"
Diameter of drivers	56"	55"	51"
Tractive effort, lbs.	71,500	71,600	98,000
Steam pressure, lbs.	235	200	215
Total wheel base	30' 8"	44' 10"	39' 2"
Driving wheel base, rigid	10'	10'	14' 3"
Total heating surface	5,585 sq. ft.	5,658 sq. ft.	6,108 sq. ft.
Grate area	72.2 sq. ft.	78 sq. ft.	100 sq. ft.

* * *

DEATH OF A. J. CASSATT.

A. J. Cassatt, president of the Pennsylvania R.R., died suddenly of heart disease, December 28, at his home in Philadelphia. He was born in Pittsburg 1839 and received a partial education in Germany. His civil engineering education was obtained at the Rensselaer Polytechnic Institute, Troy, N. Y. He began in the service of the Pennsylvania R. R. as a rodman in 1861 and soon attracted the attention of Mr. Thomas A. Scott, president of the road. From that time on his rise was rapid and he soon became an important factor



Heavy Mallet Articulated Compound for Erie Railroad.

in the executive control. In 1882 when President Roberts died it was supposed that Cassatt would naturally follow as president, but for some reason the directors chose Frank Thompson, and Mr. Cassatt resigned and retired to private life in 1882. In 1899, after having reached the age of 60 and having been out of the service of the Pennsylvania R. R. for 17 years, he was chosen president upon the death of Mr. Thompson and immediately started in on a career of expansion that is unequaled in the railway world. Space will not permit of even a brief review of this work of expansion. That connected with the tunnel and terminal work in New York City alone is a work of stupendous magnitude, the like of which does not exist elsewhere. Mr. Cassatt has the distinction of being the first railroad manager to take up the air brake.

* * *

STATISTICS OF RAILWAYS IN THE UNITED STATES FOR THE YEAR ENDING JUNE 30, 1905.

The figures in this abstract are based on summaries included in the Eighteenth Annual Statistical Report of the Interstate Commerce Commission, prepared by its statistician, as the complete report for the year ending June 30, 1905. This report is similar to preceding reports in the series. It contains tables showing details of mileage, capitalization, earnings, and expenses by roads, and besides includes many summaries of statistics for the roads as a whole.

Mileage and Capitalization of Roads.

On June 30, 1905, the report shows that the total single-track railway mileage in the United States was 218,101.04 miles, or 4,196.70 miles more than at the end of the previous year.

The operated mileage for which substantially complete returns were rendered to the Commission was 216,973.61 miles, including 7,568.95 miles of line used under trackage rights. The aggregate length of railway mileage, including tracks of all kinds, was 306,796.74 miles. This mileage was thus classified: Single track, 216,973.61 miles, as just mentioned; second track, 17,056.30 miles; third track, 1,609.63 miles; fourth track, 1,215.53 miles, and yard track and sidings, 69,941.67 miles. These figures indicate that there was an increase of 9,723.40 miles in the aggregate length of all tracks, of which 3,449.21 miles, or 35.48 per cent, represented the extension of yard track and sidings.

Equipment.

On June 30, 1905, there were in the service of the carriers 48,357 locomotives, the increase being 1,614. These locomotives, excepting 947, were classified as: Passenger, 11,618; freight, 27,869 and switching, 7,923.

The total number of cars of all classes was 1,842,871, or 44,310 more than for the year 1904. This rolling stock was thus assigned: Passenger service, 40,713 cars; freight service, 1,731,409 cars, and company's service, 70,749 cars.

The average number of locomotives per 1,000 miles of line was 223 and the average number of cars per 1,000 miles of line was 8,494. The number of passenger-miles per passenger locomotive was 2,048,558, showing an increase of 100,174 miles, as compared with the previous year. The number of ton-miles per freight locomotive was 6,690,700, showing an increase of 233,854 miles.

The number of locomotives and cars in the service of the railways aggregated 1,891,228, of which 1,641,395 were fitted with train brakes, or an increase for the year of 86,623, and 1,871,590 were fitted with automatic couplers, or an increase of 48,560.

Employes.

The reported number of persons on the pay rolls of the railways in the United States on June 30, 1905, was 1,382,196, which is equivalent to an average of 637 employes per 100 miles of line. These figures show an increase in the number of employes as compared with the year 1904 of 86,075, or 26 per 100 miles of line. Of the employes 54,817 were enginemen, 57,892 firemen, 41,061 conductors, and 111,405 were other trainmen. There were 45,532 switch tenders, crossing tenders, and watchmen.

The report includes summaries showing the average daily compensation of eighteen classes of employes for a series of years, and also the aggregate amount of compensation stated for the several classes. The total amount of wages and salaries reported as paid to employes during the year ending June 30, 1905, was $839,944,680.

Capitalization of Railway Property.

On June 30, 1905, the par value of the amount of railway capital outstanding was $13,805,258,121, which is equivalent to a capitalization of $65,926 per mile for the railways in the United States. Of this capital, there existed as stock $6,554,557,051, of which $5,180,933,907 was common, and $1,373,623,144 preferred; the remaining part, $7,250,701,070, represented funded debt, consisting of mortgage bonds, $6,024,449,023; miscellaneous obligations, $786,241,442; income bonds, $253,707,699; and equipment trust obligations, $186,302,906.

Of the total capital stock outstanding, $2,435,470,337, or 37.16 per cent, paid no dividends. The amount of dividends declared during the year was $237,964,482, being equivalent to 5.78 per cent on dividend-paying stock. For the year ending June 30, 1904, the amount of dividends declared was $221,941,049. Of the total amount of stock outstanding, $6,554,557,051, 9.72 per cent paid from 1 to 4 per cent; 14.77 per cent from 4 to 5 per cent; 10.74 per cent from 5 to 6 per cent; 8.79 per cent from 6 to 7 per cent, and 11.68 per cent from 7 to 8 per cent. The total amount of funded debt (omitting equipment trust obligations) that paid no interest was $449,100,396, or 6.36 per cent. Of mortgage bonds, $326,863,401, or 5.43 per cent; of miscellaneous obligations, $54,214,525, or 6.89 per cent, and of income bonds $68,022,470, or 26.81 per cent, paid no interest.

Public Service of Railways.

The number of passengers reported as carried by the railways in the year ending June 30, 1905, was 738,834,667, this item being 23,414,985 more than for the year ending June 30, 1904.

The number of tons of freight reported as carried (including freight received from connections) was 1,427,731,905, which exceeds the tonnage of the year 1904 by 117,832,740 tons. The ton-mileage, or the number of tons carried one mile, was 186,463,109,510, the increase being 11,941,019,933 ton-miles. The number of tons carried one mile per mile of line was 861,396, indicating an increase in the density of freight traffic of 31,920 ton-miles per mile of line.

The average revenue per passenger per mile for the year ending June 30, 1905, was 1.962 cents. For the preceding year the average was 2.006 cents. The average revenue per ton mile was 0.766 cent; the like average for the year 1904 was 0.780 cent. The earnings per train mile show an increase both for passenger and for freight trains. The figures show a slight increase in the average cost of running a train one mile. The ratio of operating expenses to earnings for the year 1905 was 66.78 per cent. For 1904 this ratio was 67.79 per cent.

Earnings and Expenses.

The gross earnings of the railways in the United States from the operation of 216,973.61 miles of line were, for the year ending June 30, 1905, $2,082,482,406, being $107,308,315 greater than for the year 1904, and for the first time exceeding the two billion mark. Their operating expenses were $1,390,602,152, or $51,705,899 more than in 1904. The following figures present a statement of gross earnings in detail and show the increase of the several items over those of the previous year: Passenger revenue, $472,694,732—increase, $28,367,741; mail, $45,426,125—increase, $926,393; express, $45,149,155—increase, $3,273,519; other earnings from passenger service, $11,040,142—increase, $125,396; freight revenue, $1,450,772,838—increase, $71,770,145; other earnings from freight service, $5,080,266—increase, $511,984; other earnings from operation, $52,319,148—increase, $2,333,137. Gross earnings from operation per mile of line averaged $9,598, the corresponding average for the year 1904 being $292 less.

The operating expenses assigned to the four general classes were: For maintenance of way and structures, $275,046,036;

maintenance of equipment, $288,441,273; conducting transportation, $771,228,666; general expenses, $55,319,805; undistributed $566,372. Operating expenses averaged $6,409 per mile of line, this average showing an increase of $101 per mile in comparison with the year 1904.

The income from operation or the net earnings of the railways amounted to $691,880,254. This amount exceeds the corresponding one for the previous year by $55,602,416. The net earnings per mile of line for 1905 averaged $3,189; for 1904, $2,998, and for 1903, $3,133. The amount of income attributable to other sources than operation was $231,898,553. There are included in this amount the following items: Income from lease of road, $114,473,139; dividends on stocks owned, $56,842,694; interest on bonds owned, $18,786,644 and miscellaneous income $41,796,076. The total income of the railways ($923,778,807)—that is, the net earnings and income from lease, investments, and miscellaneous sources—is the amount from which fixed and other charges against income are taken to ascertain the sum available for dividends. Such deductions aggregated $596,688,420, thus leaving $327,090,387 as the net income for the year ending June 30, 1905, available for dividends or surplus.

The amount of dividends declared during the year under review (including $82,415 representing other earnings to stockholders) was $238,046,897, leaving as the surplus from the operations of the year ending June 30, 1905, $89,043,490. The surplus from operations as shown for the preceding year was $56,729,331. The amount of deductions from income as stated above, $596,688,420, comprises these items: Salaries and maintenance of organization, $612,518; interest accrued on funded debt, $310,631,802; interest on current liabilities, $11,451,400; rents paid for lease of road, $116,380,644; taxes, $63,474,679; permanent improvements charged to income account, $37,720,624; other deductions, $56,416,753.

It should be understood that the preceding figures for the income and the expenditures of railway companies are compiled from the annual reports of leased roads as well as of operating roads, and thus, necessarily, include duplications in certain items of income and also of expenditure on account of the fact that, in general, the income of a leased road is the rent which it receives from the company by which it is operated.

Railway Accidents.

In their annual report to the Interstate Commerce Commission, carriers are expected to include all casualties to passengers, employes, trespassers, and other persons. The following figures, therefore, are not comparable with the returns shown in the Commission's Accident Bulletins, which are based on monthly reports, and mainly relate to casualties to passengers and to employes while on duty on or about trains:

The total number of casualties to persons on the railways for the year ending June 30, 1905, was 95,711, of which 9,703 represented the number of persons killed and 86,008 the number injured. Casualties occurred among three general classes of railway employes, as follows: Trainmen, 1,990 killed and 29,853 injured; switch tenders, crossing tenders and watchmen, 136 killed, 883 injured; other employes, 1,235 killed, 36,097 injured. The casualties to employes coupling and uncoupling cars were: Employes killed, 230; injured, 3,543. The casualties connected with coupling and uncoupling cars are assigned as follows: Trainmen killed, 217; injured, 3,316; switch tenders, crossing tenders and watchmen killed, 6; injured, 128; other employes killed, 7; injured, 99.

The casualties due to falling from trains, locomotives, or cars in motion were: Trainmen killed, 407; injured, 4,645; switch tenders, crossing tenders and watchmen killed, 12; injured, 126; other employes killed, 60; injured, 559. The casualties due to jumping on or off trains, locomotives or cars in motion were: Trainmen killed, 119; injured, 3,798; switch tenders, crossing tenders and watchmen killed, 4; injured, 111; other employes killed, 49; injured, 628. The casualties to the same three classes of employes in consequence of collisions and derailments were: Trainmen killed, 579; injured, 4,736; switch tenders, crossing tenders and watchmen killed, 8; injured, 37; other employes killed, 85; injured, 750.

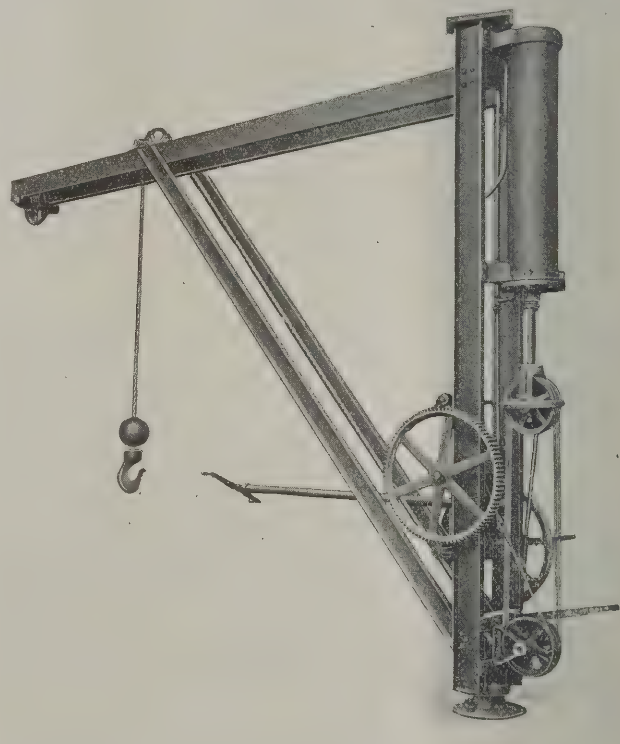
The number of passengers killed in the course of the year 1905, was 537 and the number injured 10,457. In the previous year 441 passengers were killed and 9,111 injured. There were 341 passengers killed and 6,053 injured because of collisions and derailments. The total number of persons other than employes and passengers killed was 5,805; injured, 8,718. These figures include the casualties to persons trespassing, of whom 4,865 were killed and 5,251 were injured. The total number of casualties to persons other than employes from being struck by trains, locomotives or cars was 4,569 killed and 4,163 injured.

In 1905, one passenger was killed for every 1,375,856 carried, and one injured for every 70,655 carried. For 1904 the figures show that 1,622,267 passengers were carried for one killed, and 78,523 passengers were carried for one injured. For 1895, one passenger was killed for every 2,984,832 carried, and one injured for every 213,651 carried. With respect to the number of miles traveled, the figures for 1905 show that 44,320,576 passenger miles were accomplished for each passenger killed, and 2,276,002 passenger miles for each passenger injured. For 1904 the figures were 49,712,502 passenger miles for each passenger killed, and 2,406,236 passenger miles for each passenger injured. The figures for 1895 show that 71,696,743 passenger miles were accomplished for each passenger killed, and 5,131,977 passenger miles for each passenger injured.

* * *

CURTIS COMBINATION PNEUMATIC AND HAND-POWER PITTING CRANE.

This crane was designed for pitting car wheels, but it can also be adapted for car-wheel molding. The mast, jib, and struts are made of channels riveted in place in a thorough manner; the gib is latticed on top. The upper and lower pintles are of the makers' ball-and-socket type, which allows for sagging or settling of the upper supporting member. Two



Curtis Pitting Crane.

sheathes are fitted on the jib so that an inner circle of wheels can be pitted. A Curtis air-balanced geared hoist is mounted on the back of the mast, and a hand-power winch is fitted in case of failure of air supply, or for night use. The hook is of steel, and a weight is furnished to cause the rope to descend promptly after being released. The operator does not need to move from his position to control the power lift, as the long lever connected to the hoist valve is placed in a convenient position. A brake is furnished for hand power so that the lowering speed can be regulated, and a ratchet pawl is furnished in connection with the winch, enabling the load to be held indefinitely at any point. This style of crane is made by Curtis & Co. Mfg. Co., St. Louis, Mo.

A SKEW BEVEL GEAR MODEL.

JOHN F. ARTHUR.

John F. Arthur.

In the gear model shown in Fig. 1, we have two shafts at right angles to each other in planes about 1¾ inch apart, connected at their intersection with the normal to the two planes by a pair of spiral gears, and at their outer extremities by a pair of approximate skew bevel gears. It is not possible to show the condition in the cut, but if the eye be placed at the outer end of a tooth of one of the bevel gears, it will be seen that there is a corresponding tooth of the spiral gear on the same shaft directly in line with it, and inclined at the same angle with the axis. In other words, straight teeth might be drawn from the outer edge of the bevel gear to the central spiral gear, filling all the space between them. The pitch surface on which these teeth would have to be made, though they are themselves straight, would not have a straight cross section but would be in the form of a hyperboloid. To illustrate the nature of the pitch surfaces required for a pair of skew bevel gears, I have constructed and show herewith a pair of models illustrated in Figs. 2 and 3.

To a U-frame of strap iron are fastened by clamp bolts and wing nuts the two wooden disks shown, these disks having the same axis. A groove is turned in the outer face of each disk close to the outer edge, and 20 equi-distant saw cuts are made in the periphery to a depth sufficient to just enter the grooves; this construction is best seen in Fig. 3. An endless elastic cord is interwoven in the saw cuts, being prevented from unloosening and falling out by the groove, whose lip makes a ledge to retain it in place. As shown in Fig. 3, in the normal condition the disks are so arranged that the elastic cords are all stretched parallel with the axis. A model in this condition may be considered as representing a spur gear of 20 teeth, each string representing a tooth. If two such models be placed side by side with the peripheries of the disks tangent, they may be rolled upon each other, when the strings of one may be made to coincide with the corresponding strings of the other as they revolve.

If now the left hand disk, for instance, of each model be unloosened and rotated in the same direction through a given number of degrees, the two models may again be placed in contact with each other with their axes askew by such an amount as will bring a string of one model coincident with a string of the other. With the axes fixed in these positions the two models might be revolved, when each string in turn during a complete revolution would coincide with a corresponding string on the other model. The greater the angular displacement of the adjustable disks the greater will be the angle which the axes of the two models make with each other in parallel planes. If the pitch diameters of the disks are greater than the distance between them a point will be reached, as shown in Fig. 2, when enough twist has been given each of the movable disks to bring the axes of the two models at right angles when they are put together with corresponding strings coincident. When in this condition, the outline of the surface generated by the strings as the model is rotated about its axis gives the hyperboloid or pitch surface on which it would be necessary to place teeth in the model shown in Fig. 1, if it were desired to fill up the space included between the spiral gear and the bevel gears. The shape of this surface will be understood from the left-hand view in Fig. 3, where one of the two models of Fig. 2 is shown separately.

This hyperboloidal surface may be understood by considering another method of generating it. If we take between the centers of a lathe the wooden cylinder *A B C D* as shown by the dotted lines in Fig. 4 and feed into it a knife blade *E* set at an angle as shown, this knife blade would generate a spool shaped solid having the outline indicated, and its exterior surface would be a hyperboloid. The mark which might be made by pressing with the knife into the surface of this figure when generated, the blade being in the position shown, would represent the line of contact between this solid and another one generated in the same manner, if they were put together with their curved surfaces tangent to each other. This line may also be taken as representing one of the strings in the model just described. The models and the turning lathe illustration just given demonstrate very clearly the fact that two hyperboloidal surfaces properly proportioned will touch each other on a straight line of contact.

Fig. 1. Two Shafts Connected by both Spiral and Skew Bevel Gears.

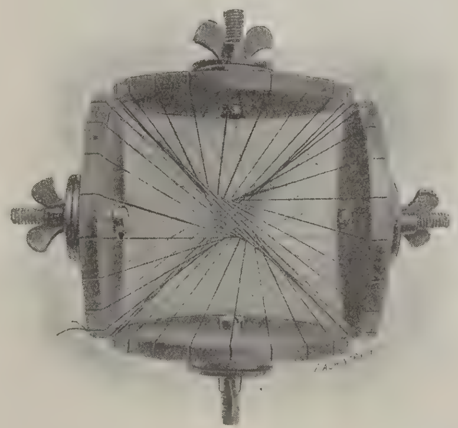


Fig. 2. Model Illustrating Two Skew Bevel Gear Pitch Surfaces in Contact.

While the set of gears shown in Fig. 1 (in combination with the string model) demonstrates the pitch surface required, it has not been given teeth which accurately fulfil the requirements of the case. The spiral gears at the center, instead of having curved pitch surfaces, have been cut with cylindrical ones which theoretically only touch at a single point in the center. With a little use, however, they wear themselves to an indescribable shape, depending on the material of which they are made, and this shape doubtless approximates the skew bevel action required. In the case of the two outer bevel gears accuracy is impossible, since the teeth slide laterally on each other, thus bringing different pitches in contact, the conditions varying constantly between the times of entering and leaving. These skew bevel gears are therefore a kind of compromise mechanism which will transmit a moderate power, but must be cut with the spaces more than half of the pitch, with the thickness of the teeth less than the standard by the same amount.

If one of the disks in the model shown at the right in

JOHN F. ARTHUR, secretary of the Arthur Co., New York was born in Glasgow, Scotland- 1870. The family came to the United States when he was eighteen months old, and settled in New York. He took up the machine business under the direction of his father, Mr. James Arthur, and went through a regular machine shop training. Mr. Arthur is a machine designer, and has taken out several patents on devices pertaining to the business of the concern, which is largely gear cutting. He has always given the subject of gear making special attention, and has constructed a number of interesting gear models, besides the above, to illustrate principles.

Fig. 3 is turned around 180 degrees, we bring all the elastic strings to a common point of intersection in the center, thus altering our skew bevel hyperboloid pitch surfaces until they become the conical pitch surfaces of bevel gears. It is of course understood that, since the elastic cord used has a sensible thickness, all of the strands cannot be brought to a common point in the case of the bevel gear. The principle illustrated, however, will readily be grasped. The skew bevel pitch

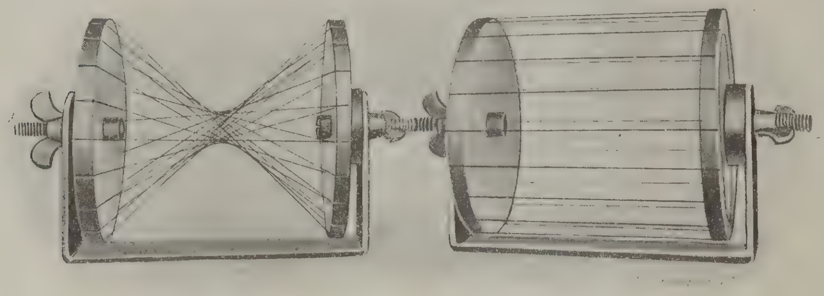


Fig. 3. Models set to show Skew Bevel Gear and Spur Gear Pitch Surfaces.

surface shown in Fig. 3 may thus be altered to the spur gear pitch surface in the same Fig. or the bevel gear pitch surface just described, all the intermediate forms being hyperboloids. The skew bevel gear is thus, in a sense, the progenitor of all other forms of gearing.

[There is a possible form of tooth which may be given to the hyperboloid pitch surface, so nicely shown by Mr. Arthur, which will give the constant angular velocity required and will permit, as well, the sliding action described as taking place between the two gears. This form of tooth, invented by Olivier, is described in Grant's "Treatise on Gear Wheels," paragraphs 175 and 176. It has no practical use, however, since it vanishes to infinitesimal dimensions at the smallest diameter of the gear, and has a great obliquity of action at the larger diameters. A modification of this form of tooth

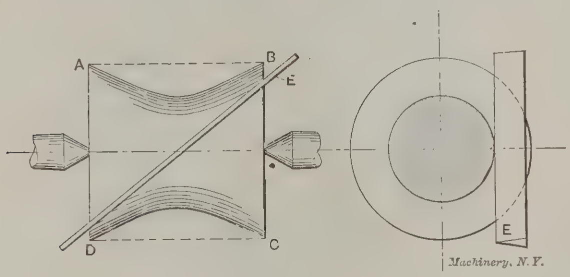


Fig. 4. Generating the Hyperboloid from a Straight Line.

was devised and tried by Mr. Beale of the Brown & Sharpe Mfg. Co., but, while it has great scientific interest, the form has little practical value, on account of the small size and weakness of the teeth and the difficulty of generating them. Considerable information is given in the book referred to above in relation to the determination of hyperboloid pitch surfaces for various shaft angles and velocity ratios. The spiral gear, however, with the exception of the worm gear, appears to be the only practical solution to the problem of connecting by a single pair of gears two shafts not in the same plane.—Editor.]

* * *

In the days of our forefathers, when rifle balls were spherical, and long, cylindrical, conical-headed bullets and rifled barrels were undreamed of, the gunsmith adopted a curious but convenient method of designating the gage or diameter of the bore. He expressed it by stating how many bullets, of a size that would fit a particular musket, would go to make a pound. Thus, a 10-bore musket would be one of such a bore that ten of its bullets would go to make a pound weight; a 16-bore gun would be one whose bullets would run sixteen to the pound, and so on. Hence we get the anomaly, that the larger denomination musket has the smaller bore. Although the day of the spherical bullet has long passed away, and the only smooth-bore remaining is the shotgun, the old method of designation has been retained until the present time.—*Scientific American.*

MAKING SMALL RELIEVED GEAR CUTTERS IN THE SLOAN & CHACE SHOPS.

The machinist who has been accustomed to the ordinary run of work, say that included in the range between the sewing machine and the ocean steamer, is likely to feel himself better acquainted with anything between these two extremes than he is with work that tends toward the microscopic, such as the making of tools and parts for clocks and watches, for instance. One of the things which aroused the particular wonder of the writer while he was still an apprentice to the machinist trade, was the minuteness of the formed and relieved gear cutters which he saw in a clock factory to which he had made a casual visit. Even taking for granted the use of the magnifying glass in making these cutters, how could the hand of the toolmaker be kept steady enough to draw correctly the proper outline or file a templet or form tool to that outline after it was drawn? With this perplexity of his apprentice days still in mind it was with renewed interest that he watched the methods used in making these small cutters in the shops of the Sloan and Chace Mfg. Co. at Newark, N. J.

In the first place, of course, there is no direct use of hand work in the actual forming of the outline of the cutter, or the form tool with which it is made. That is to be expected, and the pantograph idea would at once occur to a mechanic as being the most suitable principle to use in obtaining cor-

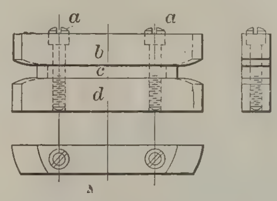


Fig. 1. A Built-up Form Tool.

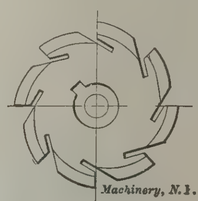


Fig. 2. Design of a Minute Formed Cutter.

rect outlines on the very small scale which has to be used. The way in which the pantograph idea is applied, however, is very ingenious, and all of the tools used in the production of these cutters show evidence of being the result of thought and experience. It must not be imagined, however, that these machines are new. They are none of them new, some of them being as old as twenty years or more. Their age, however, does not detract from their interest, and their

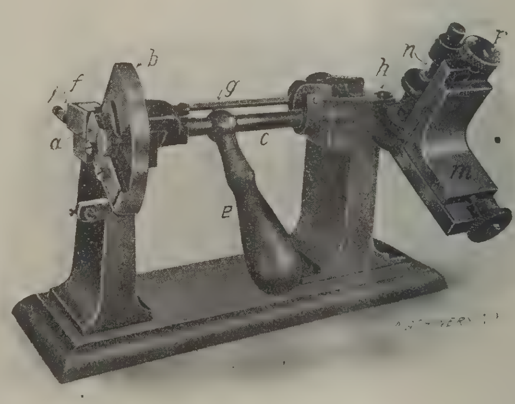


Fig. 3. Pantograph Machine for Lapping Form Tools.

construction and operation will without doubt be a matter of absolute novelty to the greater number of the readers of Machinery.

Fig. 1 shows the form tool with which the cutter is shaped and Fig. 2 shows the general type of cutter produced. After the blank has been turned up, angular saw cuts are made in its periphery to furnish a clearance space to run the emery wheel into when grinding. The ends of the projecting tooth

thus formed are then finished off to a radial line, and the blank, with the general outline shown in the cut, is ready for the relieving lathe, where it is formed by the tool in Fig. 1. This tool, as shown, is made of three parts held together by screws *a a*. Of these three parts, *b* and *d* are identical so far as the shape of their cutting edges is concerned, but are reversed in form, one being right-hand and the other left-hand. At *c* is a filling piece which forms the top of the cutter and separates the two side pieces to give the proper width

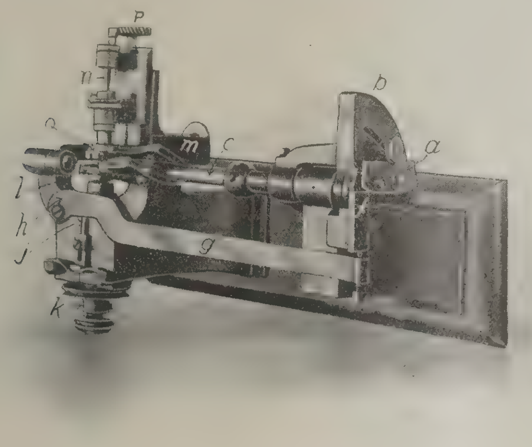


Fig. 4. Top View of Pantograph Machine.

to the top of the cutter and the bottom of the tooth space. Piece *c* is made by direct measurement; in forming the curved outlines on pieces *b* and *d*, the pantograph machine comes into play. The double-ended design of the tool is inherent in the construction of the pantograph machine, and gives it the advantage of a double life, since when one end is worn out the tool may be reversed, when the same form will be found at the other end.

The construction and operation of the pantograph machine will be understood from the photographs which are reproduced in Figs. 3 and 4. In these two views similar parts have been given the same reference letters. At *a* is a templet whose edge has been worked out to the desired outline for the side of the tooth for which the cutter to be made is intended. This outline is made on a scale of 10 to 1, this reduction being great enough to avoid any greater irregularities than would be produced by the most perfect mechanical methods possible. Templet *a* is fastened to a sector *b*, which is in turn attached to a shaft *c* and may be rotated with it by handle *e*. The templet *a* bears with its working edge upon another plate *f* which, as handle *e* is rocked up or down, transmits the motion received to the reducing lever *g*, which is pivoted at *h*. At a point one-tenth of the distance from *h*

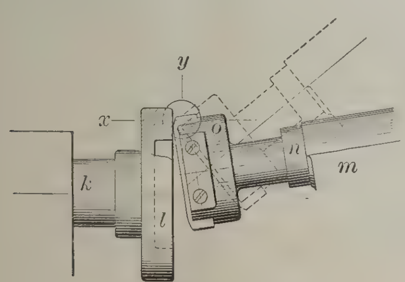


Fig. 5. Action of Diamond Lap on the Tool Blades.

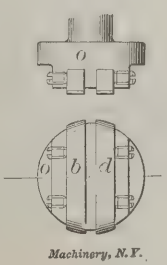


Fig. 6. Chuck for Holding Tool Blades.

to the bearing point on the plate *f* a contact pin *j* bears upon the lever, this contact pin giving the reduced motion due to the rotation of form *a* to a spindle *k*, driven as shown by a grooved wheel at its outer extremity. This spindle carries on its inner end a lapping plate *l* shown in detail in the line cut Fig. 5. This lap has its plane front surface charged with diamond dust and is the cutting member employed in shaping the form tool blades. To the further extremity of rock shaft *c* is attached a bracket *m* with suitable adjusting slides. This bracket carries a second revolving spindle *n* driven by a round belt and carrying on its inner end the chuck *o* which carries the two blades, *b* and *d* of Fig. 1, which are to be ground. These blades are held in transverse slots in the face of the chuck, being tightened in position by the headless setscrews shown. This construction will be more plainly understood by reference to line cuts 5 and 6. It will now be evident with a little thought, that, with the machine properly adjusted and the lap, tools, and templet in place as shown, if spindles *k* and *n* are revolved, the handle *e* rocked up and down, and the cross slide screw *p* fed in slowly, the outline of templet *a* will be reproduced by lap *l* on tools *b* and *d* on a scale one-tenth of the original. The intersection of the axes *x* and *y* in Fig. 5 represents the center line of the rock shaft *c*. The revolving of shaft *o* continues this form in a circular direction about the center of rotation so that *b* and *d* practically form parts of a circular form tool which may be ground in the same way that a circular form tool is without losing shape. The tools *b* and *d* are of course hardened before this operation is performed. Filling piece *c* shown in Fig. 1 is simply a portion of a plain circular disk.

After the form tool has thus been made and assembled, a blank for the cutter, made as shown in Fig. 2, is placed in the relieving machine in Fig. 7 where the outline of the form tool is given to it. All the motions of this machine are driven from pulley *a*. The further end, not shown, carries the first of a train of change gears meshing with large gear *b*. These change gears may be arranged to give, if the cutter for instance is to have twelve teeth, twelve revolutions of *a* to one of *b*. Shaft *c* carries, just back of pulley *a*, a cam which acts on a roller at the further end of lever *d*. This

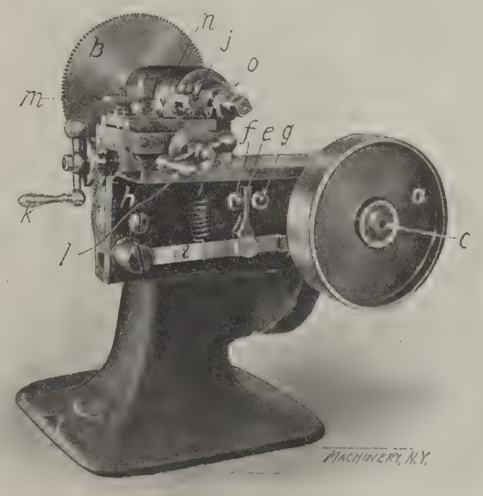


Fig. 7. Relieving Machine for Minute Formed Cutters.

lever has pivoted to it a little wedge *e* which works between stationary roller *f* and roller *g* which is fast to slide *h*. It will thus be seen that a suitable in-and-out motion for the relieving of the teeth is given to slide *h* by the rotation of pulley *a*. Slide *h* carries the tool post *j* and the two slides and their adjusting screws operated by handles *k* and *l*. The tool post *j* has also a tipping adjustment controlled by thumb-screw *m*. Form tool *n*, made by the process previously described, is placed in the tool post while the blank is held at *o* on the front end of the same spindle which carries dividing wheel *b*. The operation of the machine and the various adjustments of which it is capable will be easily understood from the cut.

It will be seen that, with this way of making, the only hand work involved in giving form to the cutter is that employed in shaping the outline of templet *a* in Figs. 3 and 4, and since this is done on a scale ten times actual size there is little chance for error. Of course the various adjustments have to be intelligently made. For instance, in the pantograph machine, the longitudinal position of lap *l* must be such that, when bearing plate *f* is moved into the center line of rock shaft *c*, the face of lap *l* will also pass through the same center line or be coincident with axis *y*, shown in Fig. 5. To provide for this, plate *f* is located on the center line and a circular plug milled down to its axis is inserted in a hole

at the further end of shaft *e*, when the lap is adjusted by the nut at the outer end of shaft *k* until it is exactly in contact with it. The necessary adjustments will suggest themselves from the various stops and screws shown in the cuts.

Such cutters as those we have just been describing will do for comparatively coarse gears and pinions, for use in the cruder sorts of time-keeping apparatus, such as alarm clocks, common eight-day clocks, etc. For fine watch gears, however, nothing but the slow-cutting single-tooth fly cutter is used. No matter how painstakingly a multiple-tooth cutter may have

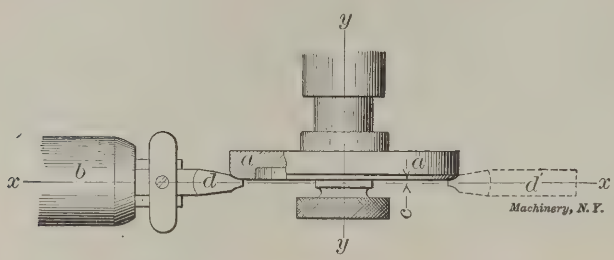


Fig. 8. Method of Lapping Fly Cutters.

been made and mounted in the machine it is to be used in, it will always run out sidewise more or less, and this means that the width of the space will not be a constant quantity. Each time the cutter is removed to be sharpened or each time the machine is set up, a different thickness of tooth will be cut. This error, of course, does not appear in the action of the fly cutter with its single cutting edge. The way in which the pantograph machine is used to make a fly cutter will be understood by reference to the line cut Fig. 8 and the halftone cut of the lapping machine in Fig. 9. At *a* is a lap with its front face formed to the required tooth curve. To give it the form desired, it was mounted at the end of spindle *n* in the place occupied by chuck *o* in Fig. 5. The tooth curve was transferred to it in the same way that the cutters are shaped, the action of lap *l* on this second lap *a* being identical with the action of lap *l* on blades *b* and *d*. Referring again to Figs. 8 and 9, *b* is an arm swinging in a horizontal plane on a vertical axis at the intersection of lines *x x* and *y y*. The distance *c* from axis *x x* to the face of the lap is made equal (when the lapping has finally been completed) to one-half the width of the tooth space at the root of the tooth. The fly tool *d*, which is being lapped into shape, is held by a collar and setscrew in a suitable recess formed in the end of mandrel *e*, which is placed in bearings on arm *b*. In operation, with lap *a* revolving, the arm is swung around

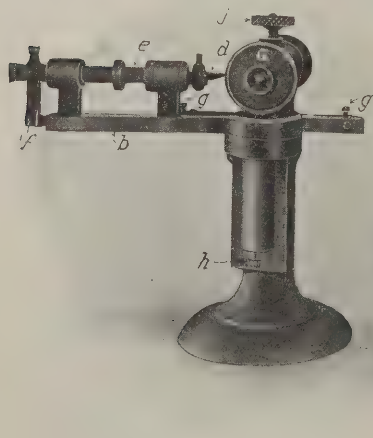


Fig. 9. Machine for Lapping Fly Cutters.

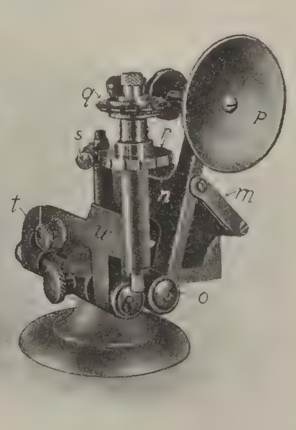


Fig. 10. Machine for Grinding Formed Cutters.

until the lap is in contact with tool *d*, when, being charged with diamond dust, it gradually under gentle pressure works it down to the form required. When one side has been thus shaped, arm *b* is swung around its vertical axis until the fly cutter is brought to position *d′* on the other side of the lap, when the other side of the tool is also formed.

To give the side relief required, an arm *f* is fastened to the outer extremity of spindle *e*. The lower end of this arm has a notch in it which is somewhat larger than the pin enclosed by it, which is driven into slide *b*. When the tool is pressed up against the lap in the position shown in Fig. 9, the lower end of this arm *f* is pushed over until this side of the notch is in contact with the pin; likewise, when, on the other hand, arm *b* is swung around to the right-hand side of the wheel, the arm is pushed over until the other side is in contact with the pin; thus spindle *e* is rotated very slightly to give clearance to the sides of the cut. The other adjustments of this machine will be readily understood. Provision is made for endwise movement of the spindle carrying lap *a*, to bring dimension *c* correct as shown in Fig. 8. Stop screws *g g* are provided, which accurately limit the swing of arm *b* in either direction to 90 degrees either side of *y y* as is required. Set screw *h* brings the cutting edge of the tool *d* in proper relation with the center line of the lap spindle. Means are provided at *j* for the very important adjustment requiring that the center line of the pivot on which arm *b* rotates shall exactly intersect axis *y y* of the lapping spindle. The fly tool is made with a triangular body which assures its being fastened always in its holder in such a way that the front cutting face is parallel with the axis of rotation.

In Fig. 10 is shown a little grinding machine used for sharpening form cutters. This operation will be readily apparent. From a pulley, not shown, motion is given to a crankshaft at the rear of the device which through crank *m* rocks frame *n* about pivot *o*. This frame carries a cupped emery wheel *p*. The cutter to be ground, shown at *q*, is mounted on the end of a vertical spindle carrying a ratchet *r* having the same

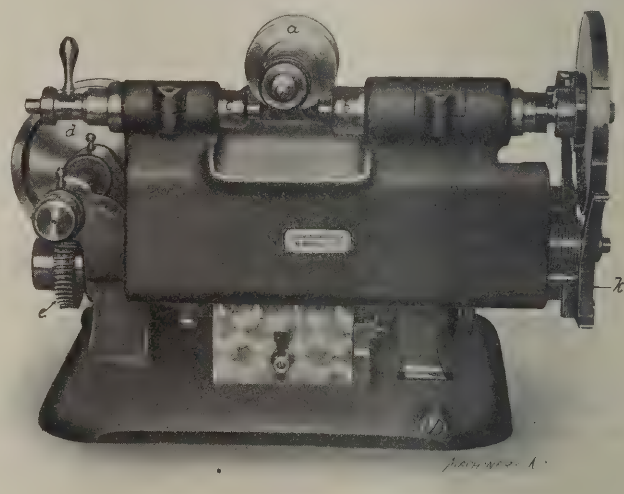


Fig. 11. Front View of Automatic Clock and Watch Pinion Cutter.

number of teeth as the cutter. Pawl *s* acts as a stop for the ratchet. Adjusting screw *t* furnishes an inward stop for frame *u* which is also pivoted at *b*, thus regulating the depth of the movement of emery wheel *p*. As the emery wheel is swung in and out by the crank, the hand of the operator indexes the cutter, stopping each tooth of the ratchet in turn against pawl *s*.

The machinery in which clock and watch gears are cut is interesting in a number of respects. Figs. 11, 12 and 13 show three views of an automatic pinion cutter made by the Sloan & Chase Mfg. Co.; of these Fig. 11 shows the working side of the machine. The pulley which drives the cutter spindle is shown at *a*. The work (which may be either in the form of staffs with pinion blanks integral with them, or in the form of blanks mounted on arbors) is gripped at either end in chucks *b* and *c*, the one at the headstock end and the other at the tailstock end. These two spindles and the work held by them are indexed by the mechanism at the right in this view. Pulley *d* drives the feeding and indexing mechanism through the worm gearing shown at *e*. This worm gear drives a shaft on which are mounted the various gears and cams for controlling the movements, which are shown to better advantage in Figs. 12 and 13. Indexing cam *f* is fast to the cam shaft just mentioned. As it revolves it comes in contact with tappet *g* on the indexing lever *h*, which, by means of a pawl rotates a ratchet fast to the work spindle. On its inward movement, before the pawl strikes the ratchet tooth, the dog *j* at the lower end of lever *h* withdraws the locking lever *k*

from the notch in the indexing dial, to permit the rotation to take place. Continuing, the forward movement of the indexing lever *h*, as it rotates the spindle through the pawl and ratchet described, brings the upper end of dog *j* in contact with a stop screw which releases the locking lever *k*, allowing its detent to drop into the notch on the periphery of the dial the moment the rotating movement has ceased. As the motion of the indexing cam is continued in the direction shown, the lever *h* returns to its normal position, dog *j* again dropping over the lower end of lever *k* as in the cut. The feed cam *l*, acting through the feed lever and the connecting link shown, gives the required horizontal movement for feeding the work past the cutters.

The machine shown is provided with a movement much used in watch gear cutting to insure extreme accuracy in the shape of the teeth, modified for this particular machine with considerable ingenuity. Three cutters may be mounted side by side on the cutter spindle. The first for taking a roughing cut, the second for an intermediate cut, and the third for the final finishing. The blank is first roughed out all the way around, then the second cut is taken, winding up with the finishing cut. The slide *n*, on which the spindle is mounted, being advanced each time an amount sufficient to bring the cutter desired to a position central with the axis of the work. At *o* in Fig. 12 is shown a six-tooth ratchet attached to a short shaft carrying three cams, located under the outer end of the spindle slide. These cams are so arranged that, as the ratchet is rotated, for each sixth of a revolution one after another of the three acts upon the inner end of one of screws *p*, thus giving the slide a longitudinal position dependent on the adjustment of the screw *p* which is being acted on at the time. Lock screws *q* are provided as shown for fastening screws *p* in position. Since the cams driven by ratchet *o* are double, the same cycle of three positions is followed in the second half of its rotation that occurred in the first half. A stiff spring keeps the spindle slide *n* in as advanced a position as is allowed by the cams and stop screws.

The action of the mechanism which changes these stops will be understood by comparing the Figs. 12 and 13. Stop dog *r* is rotated by a shaft passing through from the opposite side of the machine. This shaft makes a revolution for each revolution of the work spindle, being driven by an intermittent

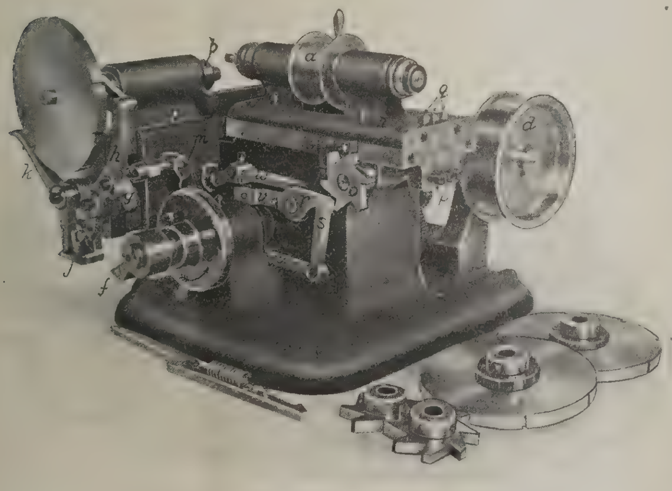


Fig. 12. Side View showing Indexing and Feeding Movement of Pinion Cutter.

gear, not shown in the cuts, from the shaft on which cams *f* and *l* are mounted. This gearing is adjustable to suit the number of teeth being cut. As this dog revolves, at the conclusion of the roughing of the teeth, it gives a sixth of a revolution to ratchet *o*, bringing a new cam and stop screw into action and centering the second cutter over the work. At the conclusion of the cut with that cutter, another sixth revolution is given to *o* in the same manner, when a third cam is presented which brings the new or finishing cutter into central position. It will be noted that by means of screws *p* the adjustment for each of these cutters is independent of the rest.

Provision is made for adjusting the depth of cut of the three cutters independently also. Lever *s*, with its fulcrum at *t*, is acted upon by the movement of the cutter slide in and out, as it brings the three different cutters into position. Rod *u*, attached to the lower end of the lever, carries on its further end three stop screws for the vertical motion of the work-holding slide on the front of the machine frame. The slide is elevated through the action of levers *v* and *w*, moved by a cam on the operating shaft, which mechanism serves to relieve the cutter on the return movement as well as to alter the adjustment when the cutters are changed. The depth of cut for each operation is determined by the three stop screws just mentioned, the one in action depending on which of the cutters is working at the time. These screws are not plainly visible in the cut.

A little thought will show that a pinion or gear cutting machine of the type shown in Figs. 11, 12 and 13, is very much

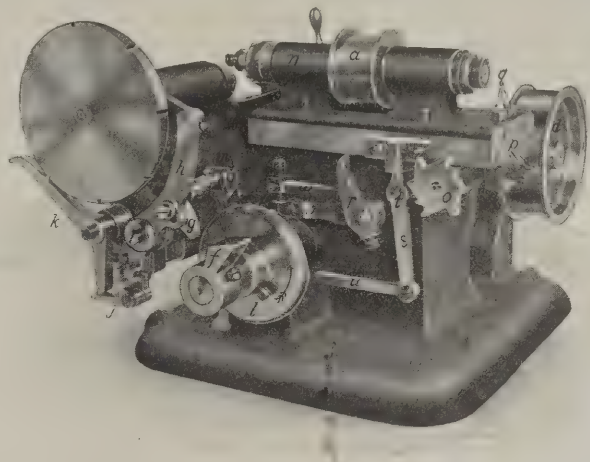


Fig. 13. Side View showing Operation of Cutter Shifting Mechanism.

more costly in proportion to its weight than the larger automatic gear cutters with which the machinist is familiar. There is, as we all know, no such thing as a perfect fit. When the slides and journals of a machine tool are fitted together, an amount of care is used depending on the purpose for which the machine is intended. If a three-pitch cutter is to be used on steel castings, a certain allowance, determined by experience, is made in fixing the diameters of the journals of the cutter spindle and box or bushing in which it revolves. The space left between the journal and the somewhat larger bearing is the oil allowance, and is filled with the lubricant provided for the bearing. If the fitting were more carefully done and a smaller allowance made at this place, not only might this oil allowance be too small to insure a film of lubricant over the whole bearing surface and so give rise to the danger of roughing it up, but the extra accuracy thus obtained would be a useless as well as an expensive luxury, since the heavy strains imposed on the structure of the machine by the action of the large cutter on the hard metal would produce deflections great enough to make of no avail the slight gain obtained by the means just described. In general, the lighter the parts are which are to be machined, the more accurately the machine may be made and must be made. In the case of a minute watch gear, an error of one-fourth of a thousandth in any dimension is a matter of as much importance as a sixty-fourth of an inch would be in the back gearing of a 28-inch lathe. Not only is accuracy thus a necessity, but the conditions that make it necessary also make it possible. In this smaller work, the slight strains imposed by the cutting action are almost lost in the comparative stiffness and rigidity of the framing of the machine, thus giving a chance for accuracy in fitting of the wearing surface to show its full measure of usefulness. The consequence is, that a carefulness of fitting in machines of this type is demanded and obtained, which makes them as expensive to build and purchase as ordinary gear cutting machines of far greater size.

* * *

It is reported from St. Petersburg that an official inquiry at Tomsk into the conduct of the Siberian Railway during the war has brought to light the fact that the government was at one station alone defrauded of $350,000, and that, on the whole line, some 1,500 cars disappeared!

VITAL NEEDS OF EVENING SCHOOLS FOR INDUSTRIAL WORKERS.

A. D. DEAN.

The next educational move in the immediate future will, I venture to say, be in the direction of improving the instruction in evening schools. Their methods should be recast. They should adapt themselves to modern industrial conditions, and through proper instruction of practical subjects touch more closely the economic and social life of the times. The evening school student attends to satisfy a definite need. Through meeting this need, a more permanent need will be created. These students have already received a more or less formal education in the public schools. They are receiving in their daily work incidental experience, and have learned from this thorough teacher that they are deficient in some lines; hence this endeavor, outside of their working hours, to fit themselves for definite lines of activity.

I shall outline what I consider to be vital needs in the organization and methods of conducting evening school work. The evening school deals with two rather distinct classes: First, those who are naturally students and seek with a definite purpose educational advantages in lines of general education; second, those who are not naturally students and yet who seek with a more or less definite aim educational help in a solution of some present problem which involves special service.

Courses Must be of Two Kinds.

The recognition of these two classes means that the courses of instruction must be of two kinds, one comparing favorably with the day school work in its general scheme, the other and major part differing decidedly from the methods ordinarily pursued. The evening work of the non-student class must have its own distinct ideals, methods, and estimates of value based upon current community conditions and individual needs rather than based on the regular school standards which are applicable primarily to the student class.

Day school teachers are employed too much at present in evening schools. These teachers can meet the needs of the student class, but they cannot properly teach the non-student class. I believe that to the custom of employing day school teachers must be laid much of the lack of definiteness in the planning of evening school work. It is a very simple matter for the average day school teacher to adopt the regular text books, and to use the regular outlines and methods. This is a perfectly consistent action, for few regular teachers have opportunity to know the vital needs of their students through their own experience. In some cities where it has not been deemed wise to employ the day teachers, the policy has been to engage young students of law, undergraduates of colleges, and retired teachers to do this most important work. Now the only people competent to teach in our evening schools are the men and women who know from their contact with modern industrial and commercial life vital points of interest which concern these workers who come to the evening schools to meet definite needs.

Evening School Instruction Must Appeal at Once.

Evening school instruction must appeal to the student immediately at the beginning of his work. The subject matter of the early lessons must satisfy his need as he has defined it. This statement may appear radical, but on second thought it will be seen to be true. For example, a young machinist has received a reprimand from his foreman because he cannot read a working drawing with sufficient skill to do properly his daily work. He enrolls in a drafting course to meet that deficiency and finds that the first two lessons are concerned with lettering plates, the next three with drawing straight and curved lines and the handling of instruments, and that the remainder of the term is to be spent on the projection of points, lines, surfaces and solids. During this time he is receiving in his daily work the same reprimands, and is therefore debating in his own mind the value of his evening instruction. It is undoubtedly true that the drawing course I have here outlined, is a proper one for teaching mechanical drawing for those who are to be draftsmen, but the average apprentice machinist does not see the direct application of this instruction to his work. He enrolled for a definite purpose. To be sure it was a narrow one, but nevertheless it had economic value to him. It would have been perfectly possible to give in the first evening some elementary instruction in the reading of simple drawings; to teach him in five lessons where to look for the dimensions denoting length, breadth and thickness; to have shown the principles of simple sectional drawings and to have him comprehend the laying out of holes for drilling. Instead of leaving school at the end of the fifth lesson with no instruction which appealed to him, he would have received enough in those five lessons to fit him to meet the needs of his foreman, and more than likely he would have remained in the drafting class to receive the more definite and thorough instruction in the theory of mechanical drawing such as must be gained if one is fully to comprehend and cover the entire range of the subject. Give to the apprentice the kind of training that will make him a good apprentice and when this point has been reached there will arise a need for another type of training suitable for the next grade which he hopes to attain.

Courses Must be Elective and Flexible.

The various features of the course must be elective and flexible and presented in small and varied units. Instead of printing in a course of study "Arithmetic," "Geometry," etc., there should be printed, "Arithmetic for Mechanics," "Arithmetic for Clerks," "Mechanical Drawing for Apprentices," etc. Where it is possible even a finer differentiation is desirable, such as "Arithmetic for Plumbers," "Arithmetic for Errand Boys," "Mechanical Drawing for Machine Tenders," etc. Not only will this presentation serve to catch the eye of the prospective student, but it will also suggest to him that special effort is to be made in the class work to help him in his daily occupation.

The instruction in the various branches must be adapted to the needs of the various occupations. The terms used in the class room must savor of the shop, office and store. From personal experience, I know that the problem, "What is ¾ths of 37½?" does not appeal so much to a clerk as the problem, "What will ¾ of a yard of cloth cost at 37½c. a yard?" On the other hand, the latter problem does not awaken the interest of the mechanic as much as the problem involving the same operations, which reads, "If a copper casting weighs 37½ pounds and specific gravity of iron is ¾ that of copper, what will the casting weigh if made of iron?"

Departmental System not Suited.

The student will do better work if the instruction in the related branches of certain occupations is given under one teacher, rather than under the departmental system of specialists in each branch. The student should not elect more than two or three subjects, the major one, bearing directly upon his daily work, the other somewhat related to the main one. It is this major subject which has drawn the student into the school and it is this which will keep him there if along with it one or two allied subjects are taught in a practical manner by the teacher of the major subject. The student will understand better the connection between these subjects because the teacher has himself a clear conception of the relationship. A machinist enrolls in an evening school for mechanical drawing and finds that he needs to "brush up" in fractions and decimals and that he needs "square root" in order to work out a formula for screw threads. I know of no time more opportune to teach him these topics than when the need for them arises, and none is more qualified to give the required practical instruction in such topics than a competent drawing teacher. When large classes demand assistant teachers, these assistants should be assigned to teaching applied mathematics through individual instruction at the drawing table or else to giving instruction to small groups in an adjoining room, keeping before the mind of the student the direct connection between arithmetic and mechanical drawing. When the student has reached a place in a drafting course dealing with the subject of screw threads, it becomes necessary for him to apply some such formula as $P = 0.24\sqrt{d + 0.625} - 0.175$, where P is the pitch of the thread and d is the diameter of the bolt. This problem involves square root and decimals.

One hour of individual or small group instruction by the drawing teacher will give a student the necessary familiarity with these mathematical processes to make them sufficiently clear to him in application to the formula. That many students are not satisfied with this hasty and incomplete instruction has been my experience, and this is often made evident through their joining the regular class in mathematics the next year in order to gain an insight into the reasons involved in the process of square root. Instead of thorough preparation in mathematics for mechanical drawing I should have the mechanical drawing lead the students into mathematics. This reversal of the usual procedure, while it may not be pedagogical so far as the subject matter is concerned, is certainly true to experience when one deals with the characteristics of the average evening school student.

Sequential Arrangement of Courses Needed.

Evening schools should have a sequential arrangement of courses. If the student's transient need is well met, it will place him in a better position, only again to make him feel a renewed need of self-improvement. This means that he will return to the evening school in some subsequent year when he ought to be given advanced work. My own experience has taught me that evening schools are so overcrowded in the elementary courses and are trying to do so much to raise a student one round in the economic ladder that these advanced students suffer through insufficient attention. If specially provided for, they might become our foremen, superintendents and managers. Not only must each school-year's work be driven home and clinched, but each series of years' work be so clinched as to meet the needs of the captains of industry, who are demanding thoroughly trained men for foremanships.

Need of Recreative Element.

Evening schools often fail to have the subject matter and its treatment glow with the recreative element. We must offer educational features in connection with physical and social privileges. The continued interest of many people is often times dependent upon identification with an associated group of varied privileges offering not only self improvement, but recreation. School buildings in our large cities equipped with libraries, gymnasiums, assembly halls, and lunch rooms should be open from 5:30 to 10 P. M. The students should be allowed to enter the building immediately from their work, be furnished a lunch at a low price, encouraged to avail themselves of bathing and library privileges, and have the opportunity for social intercourse as well as educational classes. Under modern industrial conditions it must be remembered that the employed work under a stress which is nerve wearing and physically exhausting. Oftentimes teachers in evening schools complain of general dullness as expressed by nodding heads and listless manner. If they would stop to think of the long distances traveled between shop, home and school; hurried supper; the stifling atmosphere of the school room and the glow of the electric lights, they would readily see the reason for this dullness. The general introduction of the eight-hour day, while it would make work strenuous in the extreme, at the same time shortens the day's hours of labor and ought to bring more opportunity for recreation and education. It is a duty of the evening school so to combine these two features as to result in the profit of the worker. At present young people seek recreation independently of education much to the loss of their own best interests.

Need of Division of Classes by Ages.

There should be in the evening school work a separation in the class instruction of the immature from the mature non-student class. The latter are extremely self-conscious. They are often embarrassed at having to be instructed after passing the usual school age. Their feelings should be respected as far as possible. Is it any wonder that a foreman of a pattern shop does not take kindly to being instructed in mechanical drawing in the same class with a boy machine-tender over whom he has charge during the day? This point does not have to be considered in the German continuation schools where the ages of the students are more uniform. The young men in some parts of that country are required to attend evening schools for a definite period and consequently the grading of men according to ages is unnecessary, for a young man of sixteen in the elementary class is in contact with those of similar age, and the more mature men in advanced classes, having already received elementary training, are likewise graded with those similarly prepared.

Special Text Books Suited to Evening Schools.

There should be a series of textbooks written expressly for the kind of instruction demanded in evening schools. That few such books are on the market is clear testimony that as yet a small number of teachers have recognized that there is any difference between the methods of instruction in day and evening schools. When the fact is recognized, a series of books will be published. In a careful study of the value of existing textbooks meeting the needs in all branches of one class of men, *i. e.*, men engaged in the machine trades, I have been chagrined to find that I could readily count the entire list upon the fingers of my two hands. What is needed is, for instance, not an elaborate textbook in general arithmetic with all its topics of fractions, decimals, square root, percentage, interest, partial payments, etc., but rather a book which appeals to a man in the machine trades, then one which appeals to a plumber, or a clerk, or an errand boy; small enough to slip into the side pocket of a coat and cheap enough so that he can readily own a copy for reference in his daily work.

Provision for Irregular Attendance.

Provision should be made for students who can attend but once or twice a week. Some students stay away because they cannot attend "regularly." This applies to all domestic servants. It applies also to many industrial workers. In prosperous times shops are run evenings and the men employed are expected to work over-time. They can usually get away for one night in the week during such times. They cannot always tell definitely what nights they will be called upon to work.

I know of a few schools which allow their members to attend any night or nights during the week after the work is fairly started. Such a plan is perfectly feasible in shop or drawing courses where all the instruction is individual. Some schools allow the students to do their drawing work at home during the periods of overtime work in the shop, expecting that the students will attend some night in the week to get definite instruction or data for home work.

Classification by Vocations.

Students must be classified into vocational classes according to their trade or business. The old workingman's guilds were founded for the purpose of social intercourse and mental stimulus. Each trade had its own guild. The daily trade experiences of each member became the property of all members. Discussions relating to the practices of their chosen trade occupied their attention. Is it not true that working men to-day have common trade interests? Evening school students grouped according to occupation would have an opportunity to talk over these interests. The teacher could act as a leader and draw out the students into telling their trade experiences and through the expression of these various opinions the most practical solution of the particular problem at hand would be obtained. Teachers who have had evening school experience know how difficult it is to get the students to recite and express themselves at the blackboard. A free discussion of the point at issue makes the student lose his self-consciousness and before he is aware of it he is at the board illustrating his particular method of solution. Of course such discussions must be under wise guidance.

Fee System Preferable to Free Instruction.

While it may not be feasible to charge in the public school system a small fee for the evening work, at the same time I know from personal experience that such a procedure is very desirable. That the working people can afford to pay for such instruction is evident from the large numbers who are subscribing to various correspondence school courses, and also from the fact that 69 per cent of the parents interviewed in a recent investigation conducted by the Massachusetts Commission of Industrial and Technical Education stated that

they could have afforded more schooling for their children had it been of a more practical kind. A self-supporting person appreciates what he pays for and is not only more anxious to finish his course after he has paid for it, but is also quite likely to see to it that the teachers give him what he wants. The fee system acts as a stimulus to the student and teacher. It is not necessary to charge a fee covering the entire cost. German evening schools charge only a small fee. There should be no charges for administration, lights and heat. The instruction might also be free, the school charging only for the material consumed in the shop and laboratory courses. Many superintendents of schools have expressed a wish that some fee might be charged in evening schools simply because it assists in obtaining better attendance, more earnest work, and "weeds out" those who diminish the efficiency of the school.

Evening Classes should be Attractively Advertised.

There is a need of recognizing that in adapting educational features to peculiar conditions oftentimes conservative methods will not meet the personal attitudes of those who need the service. In the matter of presentation before the public it might be well for the public schools to imitate some of the advertising methods of our more successful correspondence schools. It is not a wise business policy for a city to spend $10 on the instruction of a student when with an additional 10 cents' worth of advertising the cost per pupil could have been reduced perhaps to $8 because of the larger number enrolled and hence lessened the cost per capita chargeable to the general items of administration, heat, light and interest. Neither is it the best policy for school authorities to insert a small, obscure advertisement in the daily paper, unattractive in its wording, lacking explanation regarding the nature of the instruction and expect a working man or woman who needs such instruction to understand it or even see it. On the contrary it is good business for a city to advertise its educational features in an attractive poster on various billboards, in the office, factory and store.

Doubtless some time in the future men who are responsible for the proper conducting of evening schools will begin to realize that the desirable locations for many educational features are in the natural assembling places of the working people, especially during their leisure hours, making as much as possible the educational effort in which they participate a natural adjunct to their daily life and not a separate and distinct enterprise. I prophesy that small libraries and reading rooms, will be added to stores and factories and that practical talks and lectures will be given to the employees of these establishments. This procedure is possible probably only when there is no equipment necessary in connection with the instruction.

Growth of Correspondence Schools an Argument for Evening Schools.

The significance of the growth of correspondence schools in this country must not be lost sight of. Their rise denotes that the working people are seeking education when it is presented to them in such a way as appeals to them as meeting their needs and also when brought into close contact with their daily habits. Just so long as correspondence schools flourish, just so long will their presence illustrate the need of better evening schools. Let us consider the amount of money which goes out of the community into the coffers of correspondence schools. For instance, in Massachusetts it is estimated that there are 55,000 subscribers to correspondence schools. If on the average each subscriber has paid $40 for his course, that means that $2,200,000 has gone out of the state into the pockets of private enterprise in other states. There are 28 important industrial centers in the state of Massachusetts. This sum of money distributed to each of these centers would approximate $78,000, which at 4 per cent would net $3,120 a year. This estimate is very conservative as it only assumes that the money has already been spent and does not take into account that which is leaving the state every day as subscriptions to the various courses in these schools. The amount mentioned, if directly applied to the meeting of the economic needs of the working people through evening school instruction would give practical work of high order to over 300 students in technical and commercial work. It would mean an evening school of trades and an evening commercial high school in each of these 28 important industrial centers in addition to the regular elementary work now furnished by the municipalities. Is it not casting reflections on the cities when private enterprises take the field of educational activity which rightfully belongs to the public enterprise?

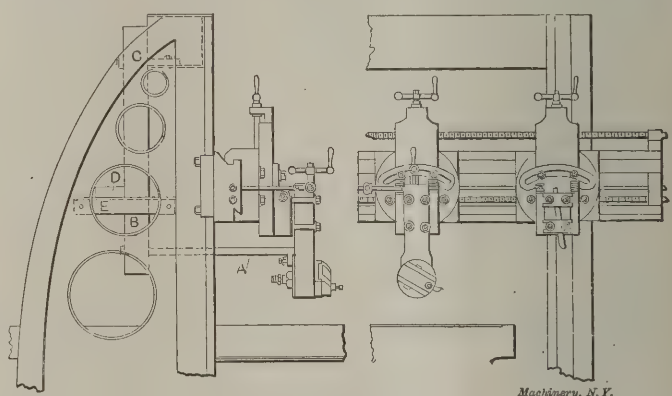
Public Schools not Meeting Present Needs.

More and more is it being recognized that the public schools are not meeting the needs of industrial life. One has only to note the tremendous growth of the correspondence schools, of the work done by the Young Men's Christian Associations with their forty thousand evening students, of the Cooper, Pratt, Lewis and Spring Garden Institutes with their class rooms and shops overflowing with evening students, the manufacturing concerns which are introducing apprenticeship systems, with evening instruction, to feel that there is a decided need for practical evening school instruction. If such education is not a function of the state, an inalienable right as it were, it might be well to acknowledge it. Is it not better to comprehend the significance of all these movements and find out the needs of the industrial workers and then meet the needs through progressive educational activity in evening schools?

* * *

BRACE FOR PLANER TOOL.

The accompanying cut taken from *Railway and Locomotive Engineering* illustrates a brace for a planer tool used by the Pennsylvania Railroad Co. in their Columbus, Ohio, shops. It is said to have increased the output of a certain class of planer work about one-third. It is employed for planing out the circular seat on driving boxes for the brasses. This seat is not a full circle, there being two lips at the lower side for holding the brasses which prevent this work from being done on a lathe or boring mill; hence the practice is to either slot



Brace for Planer Tool.

out this part or to plane it on a planer using a "radius" tool of the form shown in the cut. The feature to which particular attention is called is the brace *A* which stiffens and supports the tool, preventing heavy torsional stresses being imposed on the planer cross-rail by the roughing cuts. Its principle is similar to the planer bar with stiff support, illustrated in the October, 1904, issue of this journal. The thrust is transmitted to the housings in a different manner, however, there being a vertical member *B*, pivoted at *C* so that it can swing through an arc of limited extent, and backed up by a cross member *D* which is secured to the housings by suitable connections, as at *E*. The mechanism for operating the planer tool through the arc of a circle is not described but we infer that it is automatic in operation as it could easily be made so.

* * *

A common abbreviated method of writing dates is to write the month, day and year, thus, 9/23/06 for September 23, 1906, but an objection is that if this method is to be used it should be in logical order, *i.e.*, the day, month and year. All do not follow the same order, the consequence being that this method of recording dates is unsafe, as in some cases it is impossible to tell which is the month or year. A method followed by one of our German correspondents is to give the day, month and year, but to write the month in Roman characters, thus: 5/XI/06, *i.e.*, November 5, 1906.

ADVERTISING MACHINERY IN LARGE ESTABLISHMENTS.

Firms advertising machinery as a rule send their catalogues to the main office of the manufacturing plant where they wish to introduce their products. As a rule they are addressed to the firm, no particular individual being referred to. In the case of a small concern this works very well, no doubt. The manager of the small concern is not only giving a great deal of his time to the direct supervision of his shop, and knows what may be particularly needed, but he as a rule has a thorough technical knowledge of the requirements put on machinery. His duties, while manifold, are within a more limited sphere, and he will find time to give some personal attention to the various advertising literature reaching the office. But the case will be found to have a different aspect when we consider a large establishment. In the first place a greater amount of advertising literature reaches such a place, and secondly, the persons in charge of the concern cannot possibly be either personally in touch with the particular needs of various departments, nor possess a thorough technical knowledge as to the merits of all the various machines and appliances used in their plant. Even admitting that their ability were of more than the usual kind, and that they had mastered a great number of various fields of information, their duties are so exacting that it is doubtful whether they would give much time to studying advertising literature unless being particularly interested in some certain line of machinery. Besides these considerations we cannot overlook the fact that the leading men of large establishments are as a rule more men of business than of technical achievements, and their judgment of machinery would be largely influenced by many other considerations than those of mechanical superiority. From what has been said we may thus conclude that in a large industrial plant the advertising literature if sent to the office, largely fails to exert due influence. If reaching the office in a busy season it often finds its way too quickly to the waste basket. The man who would be interested in the catalogues never sees them, and if they are filed and indexed, as is the case in most well organized shops, but by no means in all, they are still performing no useful service, being often kept in the file only until old enough to be thrown away.

The men who largely influence the management in regard to the buying of machines in large concerns are the foremen of the various departments. They know exactly the needs of their particular part of the shop; they possess an intimate knowledge of the requirements of the machinery they use, and their interest in building up the business is greatly increased by their partaking in the selection of appliances for facilitating the output. They are the men whom the advertising literature should reach. But seldom or never will it reach them unless they send for it themselves, because their own firm as a rule does not recognize the good of sending the received catalogues to the men who would be best able to judge, and the advertisers have not as yet realized the necessity of getting in close touch with those who actually are, or at least ought to be, most active in the selection of machinery. It is therefore a timely suggestion to put forth, that our advertising manufacturers should add a request when sending their catalogues, that these latter be placed in the hands of the man actually in charge of the class of machinery advertised. Some of our leading firms have in fact already adopted this method in regard to certain kinds of their trade literature, but in the majority of cases the foremen and even the department superintendents are depending entirely upon the advertisements in the trade journals, and the catalogues which they send for themselves on account of these advertisements, for all knowledge about new advertised machines on the market. If it were not for the influence of the advertisements in the trade journals, it is likely that our manufacturers would long before this have realized that catalogues need go further than to the business office of a firm. By means of the trade journal which reaches further, the advertisers have reached the men which they should try to reach by their catalogues as well.

A EUROPEAN BEVEL GEAR GENERATING MACHINE.

The bevel gear planing machine shown herewith, built by the Ateliers de Construction Mecanique (*cidevant* Ducommun) at Mulhouse, Alsace, embodies in its design a number of features of considerable interest, among which are the linkage system which gives the proper movement to the blank, and the use of two tools, one for each side of the tooth. This ma-

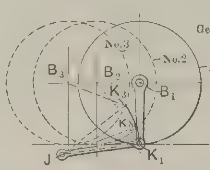


Fig. 1. Approximate Link Motion.

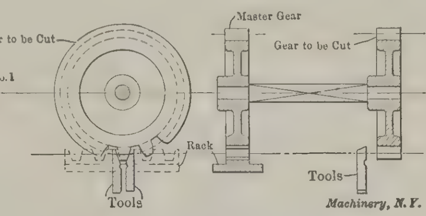


Fig. 2. Sang Method of Generating Spur Gears.

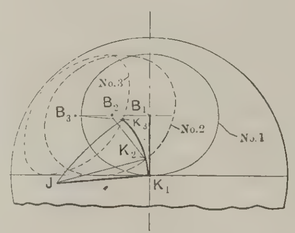


Fig. 3. Approximate Spherical Link Motion.

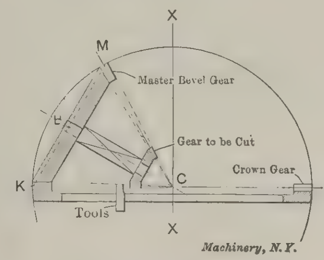


Fig. 4. Sang Method Applied to Bevel Gear Generating.

chine operates on what is known as the "Sang" system of gear generating which, in its simplest form as applied to spur gears, is illustrated in Fig. 2. The master wheel and the blank to be cut are given a lateral movement perpendicular to the axis of the shaft which connects them. This movement rolls the master gear over the rack, giving the blank a

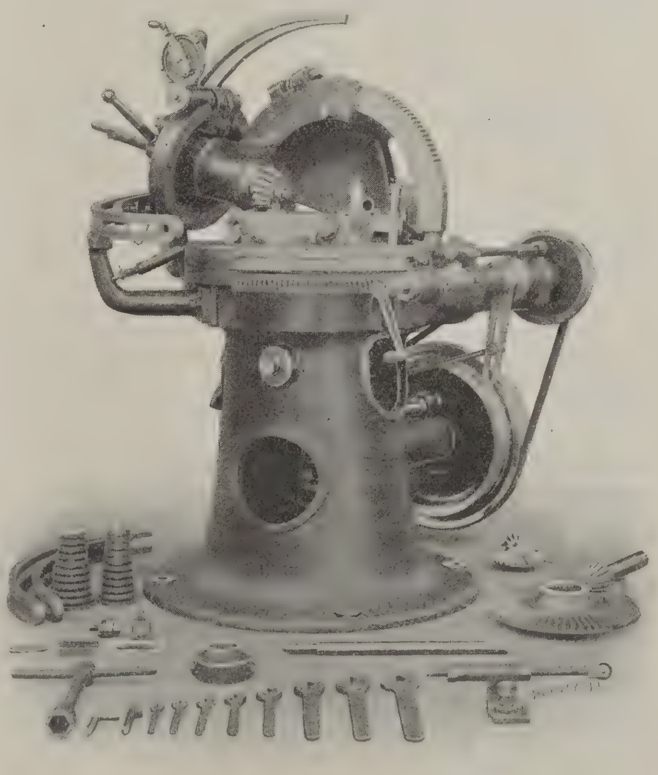


Fig. 5. A Machine Involving the Principles Illustrated in Figs. 3 and 4.

similar rolling movement over a pair of cutters which include a space corresponding in outline to the sides of the rack teeth. Thus these tools cut in the blank the tooth curves required to mesh properly with a rack whose teeth have the outline of the cutting tool edges. It is not necessary that a rack and master gear be used to give the rotary motion to the blank as its axis is translated. As shown in Fig. 1, when the pitch

circle of the master gear rolls on the pitch line of the rack, a point such as K_1 in the pitch circle of the master gear will trace a cycloid K_1, K_2, K_3. A point J can be found so located that, with this as a center, an arc can be drawn very closely approximating the cycloid. If then, instead of the master gear and rack, we substitute as shown in Fig. 1 a crank B_1 K_1 in place of the gear, and a link J K_1 to connect the crankpin with the point J determined as above described, then, when the axis of the blank is given the lateral movement described in connection with Fig. 2, the link will so restrain the movement of the crankpin K_1 that it will nearly follow the cycloid and in so doing will give the blank a close approximation to the rotary motion obtained by the gear and rack in Fig. 2.

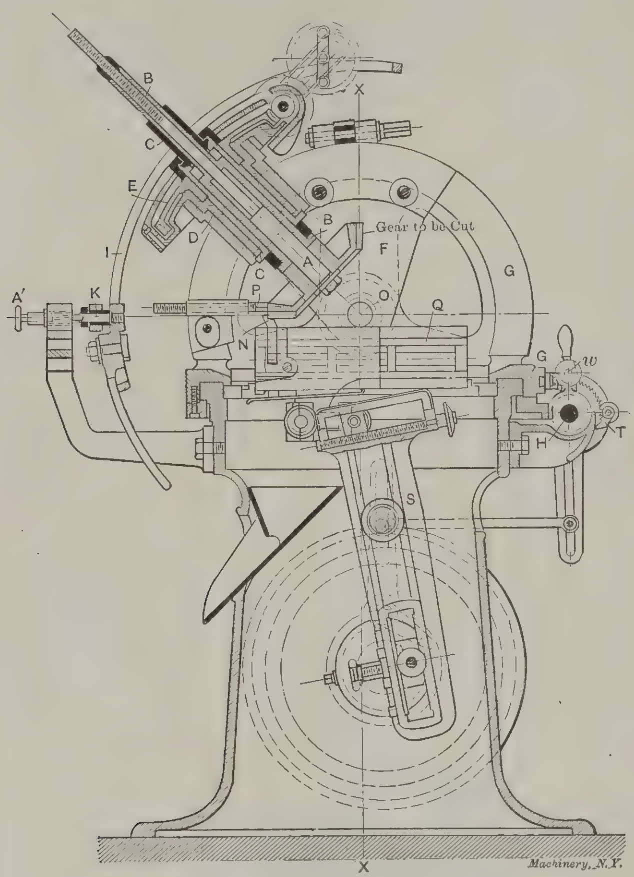


Fig. 6. Vertical Section through Plane of Work Spindle.

The Sang process as applied to the forming of bevel gears is shown in Fig. 4. The rack is replaced by a crown gear and the master gear is replaced by a master bevel gear whose axis passes through the central point of the crown gear. The gear to be cut is mounted on the axis of the master bevel gear and moves with it, and is so located that its pitch cone apex is at C, the center of the crown gear. If, then, the sides of the teeth of the crown gear be plane surfaces, a pair of tools with their cutting edges in the plane of the tooth faces of a rack space may be used to generate the teeth of the gear to be cut, when these tools are given a reciprocating motion which allows their cutting edges always to remain in the plane of the sides of the rack tooth. In this case the axis of the master gear and blank, instead of being given a rectilinear horizontal motion at right angles to the axis as in Fig. 2, is given a circular motion about vertical axis X X, so that line B C would describe a cone if it were completely revolved. The master bevel gear is thus given the proper rolling motion about the crown gear.

By a similar approximation to that illustrated in Fig. 1, we may do away with the crown gear and the master bevel gear. The pitch circle of the master bevel gear rolls about the pitch circle of the crown gear. In so doing a point K_1 in the pitch circle of the master bevel gear will, as shown in Fig. 3, describe a spherical cycloidal curve determined by points K_1, K_2, K_3, which are the positions that point K_1 takes in the three positions of the pitch circle marked No. 1, No. 2 and No. 3 in the sketch. It must be remembered, in following this action, that all the lines shown are supposed to be drawn on the surface of a sphere with C (Fig. 4) as center. Now, as in Fig. 1, we find a point J such that, with one point of the dividers located here, the other point will follow the spherical cycloid K_1, K_2, K_3 very closely. We may then, as in Fig. 1, dispense with the master and crown gears, replacing them with a crank or link, B_1 K_1, pivoted at one end to axis B C, and joined at the other end at point K_1 to the swing link pivoted at J. With this arrangement then, within reasonable limits, a rotation of axis B C in Fig. 4 about vertical axis X X will impart to the gear to be cut, through the restraining action of link J K_1, a motion similar to that given by a master bevel gear and crown gear, which will be suitable, as before explained, for shaping the correct form of tooth on the blank under the action of the two cutting tools.

The machine, Fig. 5, uses two tools, one for each side of the tooth. Since these tools, shown at N in Figs. 6 and 7, must move in separate paths converging toward point O, they are necessarily mounted on separate slides traveling on guides Q, which may be adjusted independently about the vertical axis X X of the mechanism, in the circular recess to which they are fitted in the top of the frame of the machine. This adjustment gives the necessary converging motion to cause the teeth which they form in the blank to disappear at the apex O of the crown gear and the blank. A separate adjustment, controlled by the tap bolts seen in the curved slots on the sides of the tool slide guides in Fig. 5, gives a rocking adjustment about axis O in the plane of the section in Fig. 6. This is required to make the tool follow the angle of the root of the tooth, and gives it a movement slightly out of the horizontal. The tool slides are reciprocated through ball pivoted connecting rods from slotted link S, which has the adjustment shown in Fig. 6 on its upper end for varying the position of the stroke, and an adjustable crankpin in its driving crank for varying the length of the stroke. The machine is driven through the three-step cone shown in Figs. 5 and 7.

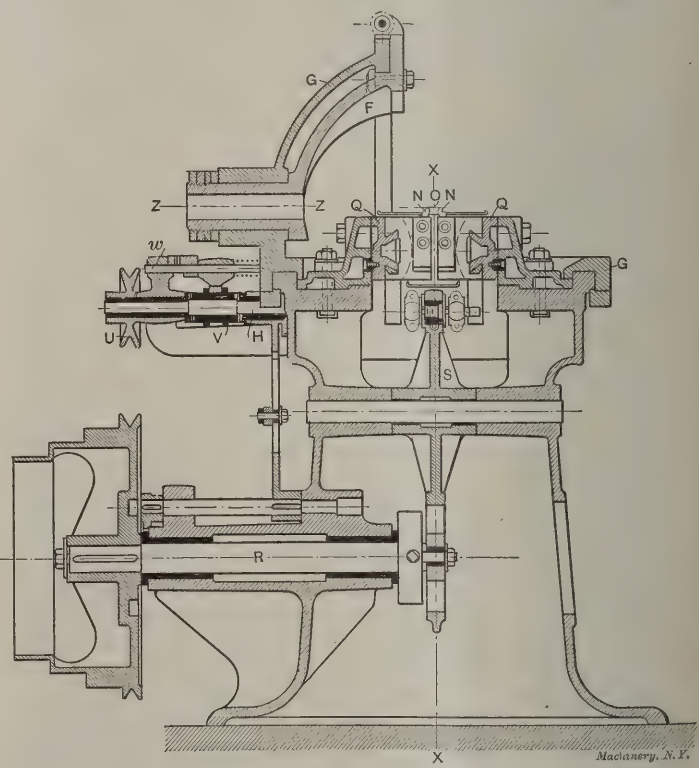


Fig. 7. Section showing Driving Mechanism.

Neglecting, for the time being, the adjustments required for suiting the machine to gears of different pitch cone angles, let us trace in the machine the action explained by the diagrams in Figs. 3 and 4. Axis B C in Fig. 4 is that passing through the gear to be cut in Fig. 6. The rotation of this axis about the vertical axis X X of the machine is effected by rotating the whole structure on which it is supported around the circular bearing provided at the top of the column of the machine. The table, carrying the structure for holding the gear blank, has a section for a worm wheel formed on a por-

tion of its periphery, as shown in Fig. 5. A worm on shaft H engages the worm wheel teeth. Shaft H may be driven either by pulley U, Fig. 7, from the belt cone for quick return movement, or by a cam in the face of the belt cone through the slotted link mechanism shown acting upon the ratchet and ratchet wheel at T, which arrangement gives the cutting feed. A clutch V connects either of these motions to shaft H. This clutch is operated by a rod w controlled by the dogs shown in Fig. 5, adjustable in the peripheral slot of the circular table. By means of these dogs the table, when started on the cutting feed, will stop itself at the conclusion of the cut and rapidly return to its first position ready for starting in on a new tooth.

So much for the movement about the axis X X. For the rolling motion which must be given the blank to agree with that of the master bevel gear rolling in a crown gear as shown in Fig. 4, the approximation outlined in Fig. 3 is used. Link I in Figs. 6 and 8 is link B_1 K_1 of Fig. 3. Point K in Figs. 6 and 8 is point K_1 in Fig. 3. In Fig. 8 pivot K has been raised from the position it should occupy directly back

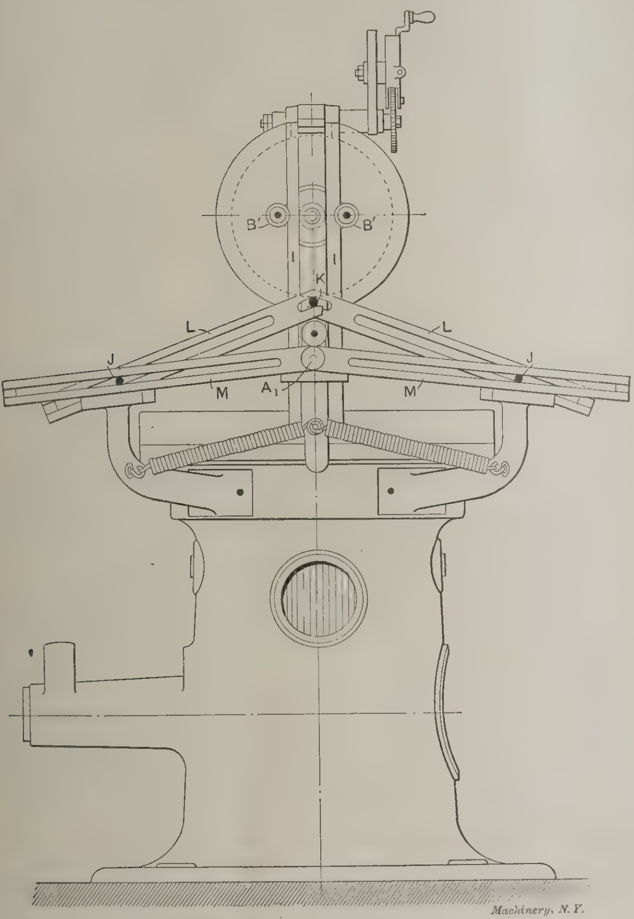


Fig. 8. Diagram showing Arrangement of Approximating Linkage.

of point A_1, to show the construction of links L. Considering however, that the mechanism is in its proper condition, when the blank is given its rotation about vertical axis X X, point K_1, if the proper rolling motion is given the blank, will trace a spherical cycloidal identical with K_1, K_2, K_3 in Fig. 3. To insure that point K shall follow with great exactness this cycloid, as the blank rolls to the left one of the pair of springs shown at the lower end of link I presses pivot K to the bottom of the open ended slot in link L, which is pivoted at point J, this point being selected in the same manner as point J in Fig. 3. It will thus be readily understood that the rotary and rolling motions required for the blank are very closely approximated. Of course the cut is not started from the middle as we have been considering. The blank is first swung to the extreme right, for instance, so that it clears the tools. Under those circumstances the pivot K will bear on the bottom of the open ended slot in the right-hand link L, being held there by the pressure of the right-hand spring. When it reaches the central position shown in Fig. 8 it will be under the restraining influence of both links L. As it continues to swing toward the left it will come under the control of left-hand link L and the left-hand spring.

The various cuts show quite clearly the adjustment required for gears of various pitch cone angles. Sector F is adjustable in a vertical plane about pitch cone apex O on its semi-circular bracket or support, which is integral with table G. This sector F carries the bearing for the blank. The entire indexing mechanism, together with the blank, is of course rotated with link I under the action of links L. The machine is semi-automatic, the indexing being done by hand through means clearly shown in the cuts. Before altering the adjustment of links L for a new pitch cone angle, the table G is first brought to the central position shown in Fig. 8. Pin A_1, shown as A' in Fig. 6, is inserted in a hole in pivot K, Nuts B' on the dividing wheel casing, through which motion is transmitted from links I to the blank, are then loosened. Sector F is adjusted and fastened in its new position on circular bracket G, and nuts B' are tightened in their new positions to correspond with the new angular setting of the head. Pivots J J are now shifted along the slots in guide bars M M to agree with graduations corresponding with the angle to which the blank-carrying spindle is set. After the pivots are tightened in their new locations, pin A_1 is withdrawn and the mechanism is ready for the gear of the new angle.

It is interesting to compare this machine with the Bilgram and Gleason bevel gear generators, both of which operate on the same principle. None of these three machines, however, bear the slightest resemblance to the others externally—an indication of the different ways in which the minds of different designers will act when the same problem is presented to each of them.

* * *

WE HAVE A NEW MAN IN OUR SHOP.

A. P. PRESS.

We had a new man come in last week. You see it is like this: Ours is a country shop, and it is hard work to get a good man; this fellow came along in the office and asked for a job, and said if the boss could stand for his coming in at 8:00 A. M. every morning he would like to go to work. He said it was not convenient for him to get in at 7:00.

Now lots of men come in on the train about 7:15, so the "Boss" said it would be all right, and the next morning at 7:55 in he came. He had a good kit of tools, knew how to use them, and was a good "all-round" man. He turned off more work that first day than I ever saw a new man do before. He had better clothes on than I had when I got married, but he took a clean pair of overalls out of his box, rolled up his sleeves, and showed he wasn't afraid of dirt.

I got to talking with him the first noon, and I found he knew things. One of the first jobs he had to do was to turn up a big, round brass ball about 6 inches diameter—a model of something or other, I think—and I thought he would be stuck. But, not a bit of it; he just put a piece of 2 x 6-inch plank on the faceplate, turned out a place in it that fitted the ball snugly, gave it a "chuck in" and then hand-tooled it up.

He had been here a week or two when our observing "Boss" noticed that he went in a certain house every night, and finally asked him if he lived there. "Sure!" he replied. "Well, if you live there, close to the shop, why don't you get in at 7:00 o'clock?" "Why! I told you when I hired out that it was not convenient for me to do so; you see it seems better for my constitution to lie abed until 7:00." Now, he is a big, strong fellow with the constitution of a giant. The "Boss" was wild and he started to "fling it" into him. "Hold up," said the new man. "Haven't I kept my agreement in both the letter and the spirit, and haven't I given you a dollar's worth of goods for every hundred cents I received? If you want to cancel that agreement, there is a first-class chance for you to do so, right now."

The "Boss" stopped right there and then, and so far the fellow has been coming in at 7:55 just the same, but whether he is a union man and is trying to make this a nine-hour shop, or whether he is plain lazy and doesn't want to work that other hour, we haven't made up our minds yet, but when we have, we will let you know.

DRILL JIGS.—3.

E. R. MARKHAM.

Form of the Jig.—The shape and style of the jig must depend on the character of the work, the number of pieces to be drilled, and the degree of accuracy essential. It may be that a simple slab jig of the design shown in Fig. 20 will answer the purpose; if so, it would be folly to make a more expensive tool. If we are to drill a piece of work of the design shown to the left in Fig. 21 and but one hole is to be drilled in each piece, then a jig made in the form of an angle iron, as shown to the right in Fig. 21, works nicely, and is cheaply made. As it is not necessary to move the jig around on the drill press table it may, after locating exactly, be securely fastened to the table. In designing such a jig, it is advisable, when possible, to have the work on the side of the upright shown in Fig. 21, rather than on the opposite side, as we do away with any tendency of the jig to tip when pressure is applied in the operation of drilling.

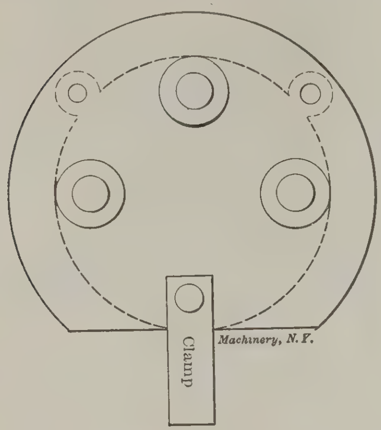


Fig. 20. Slab Jig of Simplest Design.

For many kinds of work a jig provided with a leaf, as shown in Fig. 22, gives best results, as the leaf may be raised, and the work removed, and any dirt cleaned from the working surfaces. After placing the piece to be drilled in the jig, the leaf is closed. As the bushings are in the leaf, it is apparent that it must always occupy the same relative position to the work for the different pieces, or they will not be duplicates; consequently the fulcrum pin, *a*, must be a perfect fit in the hole in the leaf, and a locating pin *b* is provided to prevent any tendency of the leaf to move from the action of the drill when cutting. Jigs provided with such a pin show less tendency to wear in the joint. The leaf should not close down onto the work, but onto a shoulder on pin *b* as shown, there being a space between the work and the jig leaf.

While the above is true for most work, a jig for drilling round pieces may be designed as shown in Fig. 23, the holding device being two V-shaped blocks, one located on the lower portion of the jig, while the other is on the leaf, as shown. In the case of a jig of this pattern the work is securely held by binding the cylindrical piece by pressing the handles of the jig together.

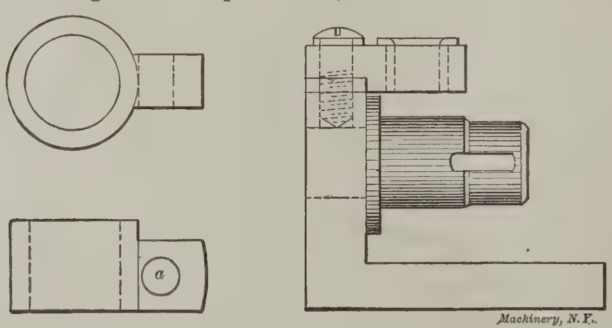


Fig. 21. Piece to be Drilled and Jig Used for this Work.

When jigs are to be moved around on the table of the drill press as is the case where several holes are to be drilled, legs are generally provided, as shown in Fig. 22. In order that the legs may not wear it is customary to harden them. The legs are hardened before they are placed in the jig, and are ground and lapped true while in the jig. As the only wear is on the ends, or where they come in contact with the drill press table, it is customary to harden only the ends which rest on the table. In most shops jig legs are made from tool steel, although a good grade of open-hearth steel containing sufficient carbon to insure its hardening answers as well for most purposes. But as few shops carry such steel in stock, crucible tool steel is generally used. The ends of the legs should be ground true with the seating surface—that is, where the work rests—of the jig. To accomplish this a surface grinder should be used. As the operation of grinding leaves a number of projections on the surface ground, and as these ridges or projections would wear away as the legs were moved back and forth on the drill press table, it is advisable to remove them by lapping on a flat lap, thus producing a perfectly smooth, true surface. In this way we reduce the wear to the minimum.

For certain classes of jigs the legs may be short, not more than ½ inch long; but for jigs of the style shown in Fig. 22, where the tool is held in the hand, it is necessary to make the legs longer to keep the fingers from coming in contact with the chips on the drill press table. The legs should be located so as to do away with any tendency of the jig to tip up when the work is being drilled.

While it is necessary to observe extreme care in designing drill jigs to prevent any tendency of the jig to tip, and to have the legs ground and lapped on a true plane, it is just as necessary that the drill press table should be perfectly at right angles to the spindle, and that it should be true and flat. Otherwise the holes will not be at the desired angle with the working surface of the work.

In shops where interchangeable work is produced, or where the work must in all respects be machined correctly, the condition of the various machines is closely watched, and especially such parts of the machines as affect the accuracy of the finished product. Drill press tables are planed over when out of true, or are lined up to insure their being at right angles to the spindles of the drill press. This may be done by placing a bent wire in the drill chuck, the wire being bent so that it will describe as large a circle as possible, and yet be free to swing. The end of the wire is bent so that a point will come in contact with the table. By loosening the screws holding the table, and inserting "shims," it may be trued as desired.

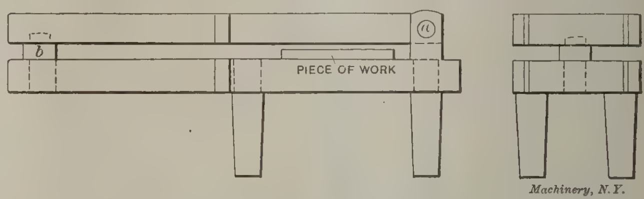


Fig. 22. Jig with Pivoted Leaf.

Locating the Holes for Drill Bushings.—When making jigs, the part of the work that calls for the best workmanship is locating the holes for drill bushings. The methods employed differ, but should depend on the character of the work. Where accuracy is not essential it is the custom many times to take a piece of work that is right, that is, one where the holes are drilled near enough right, place this in the jig and transfer the holes into the jig. As it is necessary to leave the bushing holes in the jig considerably larger than the holes in the work in order to have sufficient stock around the holes in the bushing, those in the jig may be enlarged by means of a counterbore, the pilot of which fits nicely in the transferred holes, and with a body the size of the desired hole. When this method would not insure desired accuracy, several other methods may be employed.

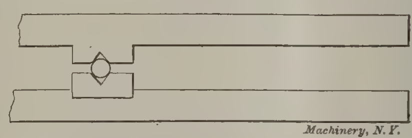


Fig. 23. Part of Jig with Pivoted Leaf, showing Method of Holding Round Work.

If a model of the work to be done is at hand a jig, as shown in Fig. 22, may be made in the following way. The leaf is raised and the model placed in it. The jig is fastened to the faceplate of the lathe, the leaf still being raised. By means of a center indicator the jig is located so that one hole of the model runs true, the leaf is then closed and the hole is drilled through it, and then bored with a boring tool to the desired size. Never ream a bushing hole in a jig, or

any similar hole in any piece of work, where the finished hole must be exactly located, as a reamer is liable to run out somewhat, and thus affect the accuracy of the work. A reamer, if properly made and used, will produce a round, true hole, accurate as to size, and is a valuable tool for many purposes, and holes of a uniform size may be produced. But on account of the stock being uneven in texture, or on account of blow holes in castings, a reamer is liable to alter its course and so change the location of the hole. While for many purposes this slight alteration of location might be of no account, yet for work where accuracy is essential, it is out of the question.

After drilling and boring the first hole the jig may be moved on the faceplate, and the other holes produced. It is obvious that in order to produce holes that will be at right angles to the base of the jig, the faceplate of the lathe must run true, and should be tested each time it is used for any work where accuracy must be observed.

Where there is no model, and it is not considered advisable to make working models of the various parts, the location of the bushing holes may be obtained by laying out the various points on the jig. In such cases a drawing is usually furnished, and the dimensions on same are transferred to the face of the jig. If it is not necessary to have the holes exact as to measurements, the laying out may be done with a

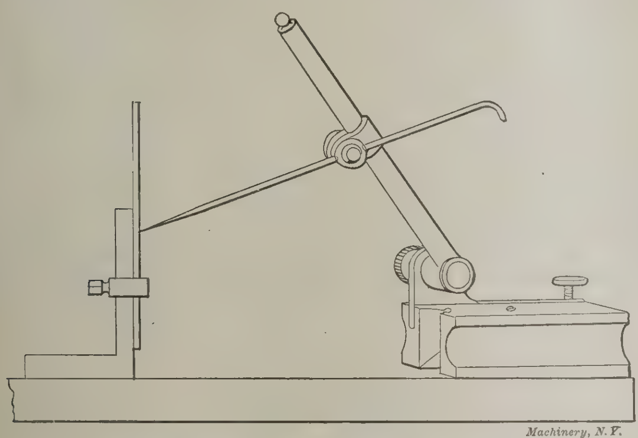


Fig. 24. Method of Taking Vertical Measurements.

surface gage, the point of the needle being set to a scale. The scale may be clamped against an angle iron, as shown in Fig. 24, or an angle iron may have a groove of the width of the scale cut across its face at right angles to the base, as shown in Fig. 25. The scale should be a good fit in the groove, so fitted that it will stay securely at any point from frictional contact with the sides of the slot, or a spring may be located as to insure the proper tension.

Where greater accuracy is essential the working points should be obtained by means of a height gage, as shown in Fig. 26. By means of such a tool the measurements may be fairly accurate, as the Vernier scale allows of readings to one thousandth inch.

When the lines have been scribed at the proper locations they are prick punched. In order to prick punch exactly at the intersection of lines the operator must wear a powerful

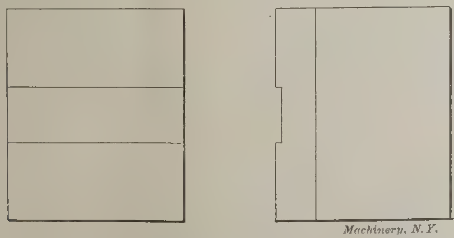


Fig. 25. Angle Iron with Groove for Scale.

eye-glass and use a carefully-pointed punch ground to an angle of 60 degrees. If the punch marks are made very light at first the exact location may be observed nicely. The punch marks should not be deep, as there is a liability of alteration of location if the punch is struck with heavy blows. After the various points have been located and punched the jig may be clamped to the faceplate of the lathe and the bushing holes carefully drilled and bored to size.

At times jigs are made of such size and design that it seems wise to core the bushing holes. In such cases it is necessary, in order that we may lay out the location of the centers of desired holes to press a piece of sheet steel or

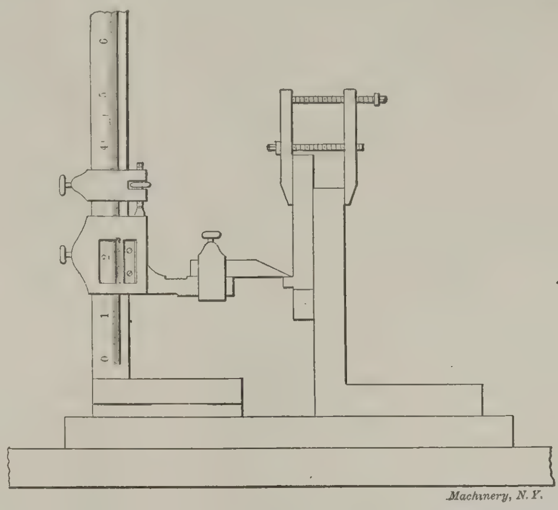


Fig. 26. Taking Vertical Measurements by Means of Height Gage.

sheet brass into the cored hole, as shown in Fig. 27, and locate the center on this piece. When the jig has been properly located for machining, the sheet metal may be removed and the hole machined to desired size. If an error of 0.001 or 0.002 inch is not permissible the method described above will not answer.

Where extreme accuracy is essential we must locate round pieces of steel on the face of our work. These pieces of steel are called buttons and are of exact size and perfectly round. To do away with any possibility of their becoming bruised in any way they are hardened and carefully ground to size. The buttons are attached to the work by means of machine screws, as shown in Fig. 28, the holes in the buttons being larger than the screws used; this difference in size allows us to move the button until it is accurately located. The diameter of the buttons should be some standard size,

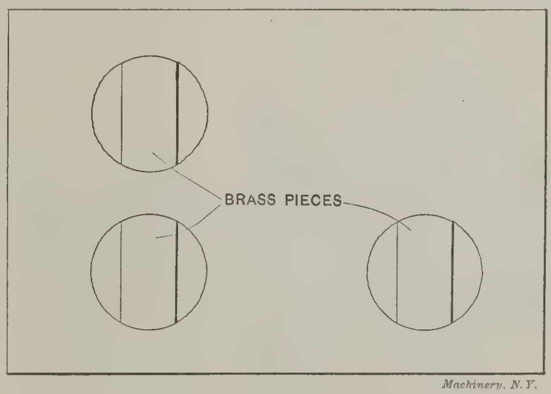


Fig. 27. Cored Holes with Inserted Brass Pieces for Centers.

easily divisible by two, because, in making our computations we only consider the distance from the center of the button to its circumference, that is, the radius.

When we start to lay out the centers for the bushing holes we first determine our working surface, then lay out on the face of the jig, by means of a surface gage, as described in a previous operation, the centers of the holes to be produced. We then drill and tap screw holes to receive the screws to be used in holding the buttons to the jig. When we have prick-punched the surface and before drilling the holes we scribe by means of dividers a circle of the size of the button on the face of the jig with the punch mark as center. This enables us to approximately locate the button. If the hole to be produced has its center 2 inches from the base *a* and 4 inches from vertical side *b*, Fig. 29, we would locate the button—provided it was ½ inch diameter—1¾ inches from *a*, and 3¾ inches from *b*. This can be done accurately by use

of a Vernier caliper, or we can lay the jig on the side *b*, and by means of a length gage, or a piece of wire filed to the right length, accurately determine the distance from *b* to the button. The jig is then placed on the base *a* and the other dimension obtained in the same manner. The buttons may be located more easily by the use of a Vernier height gage, if one is at hand.

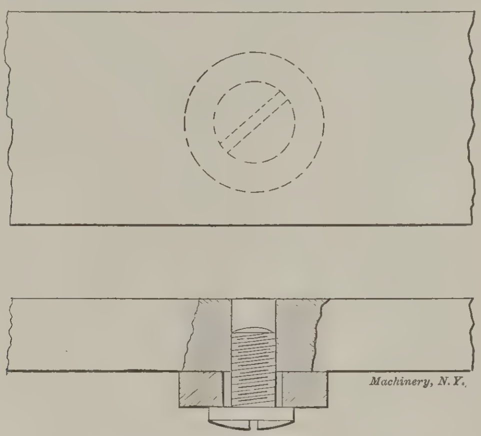


Fig. 28. Buttons for Locating Holes in Jigs.

If there are to be several bushings on the face of a jig a button may be accurately located where each hole is to be. The jig may be clamped to the faceplate of the lathe so that one button is located to run exactly true. This is done by means of a lathe indicator. When the jig has been so located that the button runs perfectly true, the button may be removed and the hole enlarged by means of a drill so that a boring tool can be used to bore it to the proper diameter.

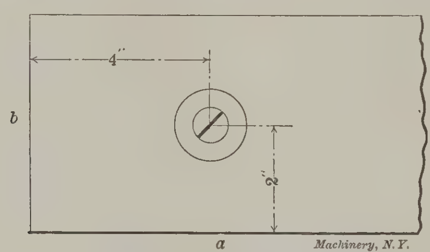


Fig. 29. Locating a Hole by Means of a Button.

In some shops it is not considered advisable to locate a button at the desired position of each bushing hole. One button is located and the jig is fastened to the table of a milling machine having a corrected screw for each adjustment. Then, after one hole is accurately located and bored, it is a comparatively easy matter, by means of graduated dials, to obtain the other locations; however, this method should never be used unless the machine has all its movements governed by "corrected" screws, as the screws ordinarily sent out on milling machines are not correct as to pitch, and if used serious defects in measurement will result.

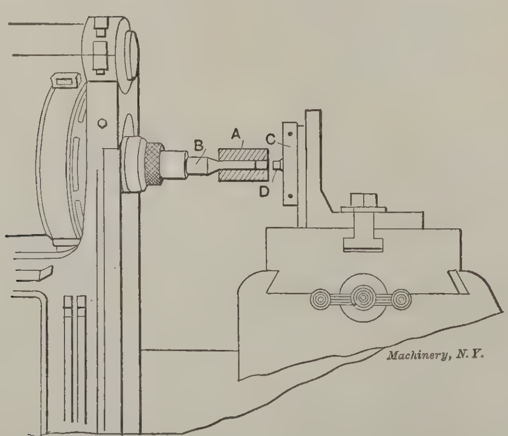


Fig. 30. Locating Holes in the Milling Machine.

Fig. 30 shows a jig clamped to an angle iron on the table of the milling machine. The angle iron is located exactly in line with the travel of the table, and the jig fastened to it. The button *D* which has previously been accurately located serves as a starting point, and the jig must be located so that the button is exactly in line with the spindle of the machine. This is accomplished by moving the table until the sleeve *A* on the arbor *B* will just slide over the button *D*. The hole in *A* must be a nice sliding fit on the arbor *B* and also on the button *D*. In order to insure accuracy, the arbor *B* must be turned to size in the spindle just as it is to be used, or, if a portable grinder is at hand the arbor may be fitted to the spindle hole or to the collet, as the case may be, the portion which receives the sleeve *A* may be left a trifle large and ground to size in place in the machine. The portable grinder is located on the table of the machine.

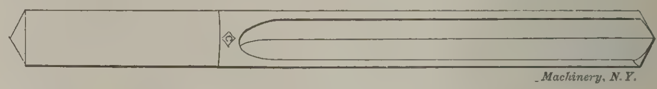


Fig. 31. Straight-fluted Drill for Jig Work.

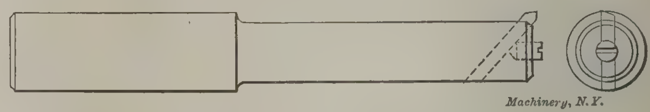


Fig. 32. Inserted Cutter Boring Tool.

After the jig has been accurately located so that the button *D* allows the sleeve *A* to slide over it, the arbor *B* may be removed from the spindle, and a drill be employed to increase the size of the tapped screw hole that received the screw used in fastening the button. Best results follow if a straight-fluted drill, as shown in Fig. 31, is used. The drill should not project from the chuck or collet any further than necessary, thus insuring the greatest rigidity possible. After drilling, a boring tool of the form shown in Fig. 32 may be substituted for the drill and the hole bored to size. The machine may now be moved to position for the next bushing hole by observing the dimensions given. The operator should bear in mind that the screw used in getting the spacings must be turned in the same direction at all times, otherwise the backlash will render accuracy out of the question.

While the foregoing relates to plain jigs the same principles apply to those of more complicated design.

* * *

How many readers of MACHINERY have ever noticed that a boiler plate sheet when formed into the shape of a boiler shell does not bend on its center line or nominal neutral axis? A boilermaker always takes the measure of the straight sheet for a certain outside girth, and makes little or no allowance for change of length due to bending. When a sheet is in the bending rolls it may be noted that practically all the scale cracks loose from the interior of the shell and very little drops off from the exterior. The fact that there is little or no change in length of the outside fibers indicates that the inner fibers are compressed and that the sheet as a whole is thickened slightly, and this is what actually takes place. It is somewhat difficult to understand why this peculiar action takes place until it is remembered that bending a bar of, say, approximately square section, narrows its exterior width and thickens the interior width inasmuch as it then bends on its neutral axis or center line, but the great width of the boiler sheet as compared with its thickness precludes the possibility of the sheet narrowing throughout its width in order to compensate for the stretching exterior fibers, the consequence being that the sheet does not change its cross section materially in shape beyond thickening it a slight amount as just indicated. Hence the exterior fibers are not changed in length, but the inner ones are shortened.

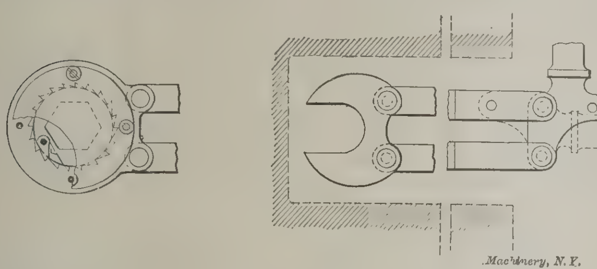
* * *

The great gulf that often exists between the theorist and the practical man is very well illustrated by an incident mentioned in the *Valve World*. It says that Lord Kelvin, the famous English scientist, once paid a visit to the schoolship for navigation officers at Portsmouth, England. On board there were several mechanical appliances of his own invention, but the workings had to be explained to him. He understood the theoretical principles of the mechanism, but had never seen them applied at work before and could not readily comprehend them when embodied in metal.

ITEMS OF MECHANICAL INTEREST.

A WRENCH FOR CONFINED SPACES.

The device shown in the cut will enable a workman to turn a nut or tap screw at the extreme end of a radial pocket of great length and small dimensions. It may be made, as shown, either as a ratchet wrench or as a solid jaw wrench, the part that engages the head of the nut in either case being rotated through a short arc of action by the two links, which are operated by the bell crank and handle at the outer end.

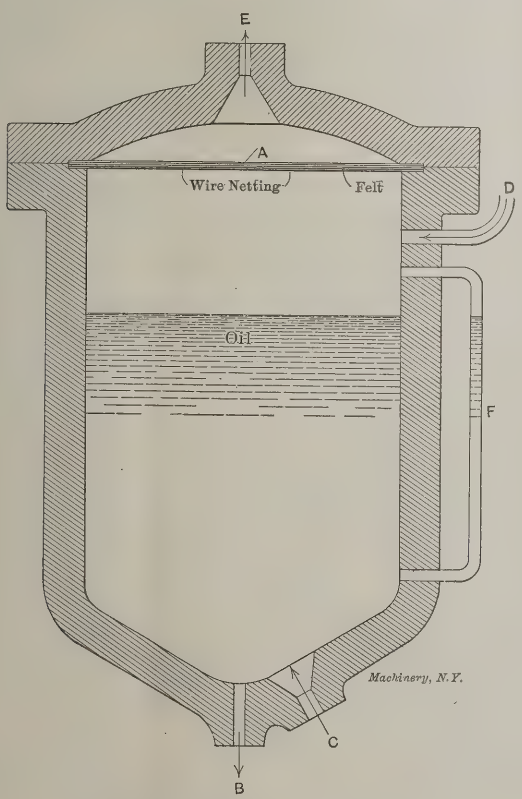


A Wrench for Confined Spaces.

This bell crank and its attached handle may be given either of two positions, as shown in the cut; the full lines indicate a position at right angles to the vibrating links, while the dotted lines show an alternative arrangement obtained by shifting one of the pivot pins. The choice of these two positions is determined by the amount of room available for swinging the handle. The idea has been patented in England and Germany.

SEPARATOR FOR WATER IN COMPRESSED AIR.

As is well-known, atmospheric air contains a certain amount of water and its capacity for water increases with the temperature of the air. When compressed, this water is carried with the air through the pipes to places where the air is to be used, and as the air is often cooled off to a great extent



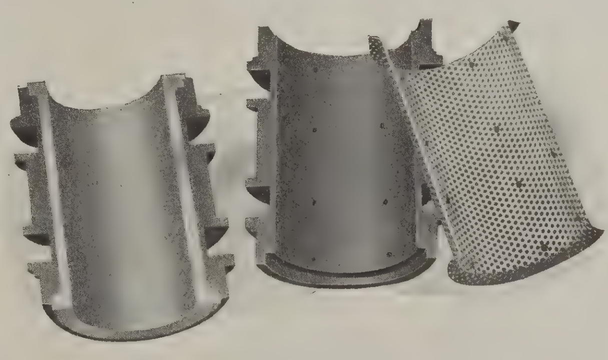
Separator for Water in Compressed Air.

during its passage through long pipe lines the water has a tendency to condense in a greater or less degree. When used in manufacturing establishments, for auto-pneumatic machinery, as has of late become more and more common, the condensed water following the air often causes troubles. When the machines are shut down the water is collecting and will cause rusting of the parts with consequent difficulty of starting the machine and making the pistons and valves move freely. To overcome the troubles thus met with, and in order to separate the condensed water from the air, a simple arrangement may be adopted. A cast iron receiver in the form of a cylinder, as shown in the cut, and provided with a cover, is nearly filled with oil, and air is caused to pass through the oil before passing into the machine. The condensed water will then stay with the oil, while the air will proceed through a filter, a shown in the cut at *A*. As the specific gravity of water is greater than that of oil, the water will evidently collect at the bottom of the receiver and can be let out whenever a sufficient amount is collected. In the cut the outlet for the water is shown at *B*, the main air supply at *C*, the pipe for the oil supply at *D*, and the outlet of the air to the machines at *E*. The oil is of course replaced only when the volume is diminished to a considerable degree owing to some particles of oil escaping at the time when the water is let out. An ordinary water gage, as indicated at *F* may be used to indicate the height of the oil or the amount of oil and water in the receiver. The felt filter is held in place between two sheets of fine wire netting which are fastened in small recesses, one to the cover and one to the receiver itself.

There may be a question about whether the oil plays any important role in the separation of the condensed water from the air, inasmuch as it is very likely that if the air containing condensed particles of water were simply discharged into the large receiver, the water would probably collect just the same. Where the writer has seen this receiver used it is always used with oil, but it would be of interest if experiments could be made to ascertain whether the oil is an essential part or not.

THE "GLYCO" SKELETON LINING FOR BEARINGS.

The accompanying cut shows an unusual and interesting way of securing the babbitt to a cast iron bearing. A tinned sheet iron lining is perforated and screwed onto the cast iron body of the bearing. The screws are provided with wood screw heads, and the holes in the cast iron body are countersunk so that the screws can bend the thin sheet metal downward around the head, and wedge it in between the head and the cast iron, thus holding the lining in place very securely. The babbitt is then poured on the tinned lining and fuses with it to a solid mass. The babbitt also fills all the small perforations and in doing so not only gets a very firm support on the cast iron below the lining, but will be still more firmly held in place than by the fusion of the metals alone, some-



The "Glyco" Skeleton Lining for Bearings.

what in a similar way as plaster is secured to the walls of a building. The advantages which are claimed for this way of making a bearing, which has its origin in Germany, are that the babbitt is held in place even more securely than if the cast iron body of the bearing were provided with dove-tail slots; the babbitt lining of the bearing can be thinner on account of the uniform way in which it is held to the body; the cast iron body itself can be made thinner, not being provided with grooves of any kind which impair its strength. This, of course, would decrease the cost of castings in cases of production on a large scale. The linings themselves can be produced very cheaply if made in quantities. They are known as the Glyco skeleton linings for bearings, and are manufactured by the Glyco Metall Gesellschaft, G. m. b. H., Wiesbaden, Germany.

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RAILWAY MACHINERY

A SPECIAL EDITION OF MACHINERY FOR THE RAILWAY SHOP, DEVOTED TO LOCOMOTIVE AND CAR EQUIPMENT AND MECHANICS.

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We solicit communications from practical men on subjects pertaining to railway machine shop practice, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

JANUARY, 1907.

The Pennsylvania Railroad Co. ordered a 10 per cent increase of wages to its 110,000 employees to take effect December 1, 1906. The increase applies to all employees receiving less than $200 per month. Other railroads are increasing wages generally and it certainly seems necessary when it is considered that rent, food, clothing, and all the other necessities of life have probably increased considerably more than 10 per cent in cost within the past few years.

* * *

THE EFFECT OF WATERPOWER ON THE ELECTRIFICATION OF RAILROADS.

While electrification of railroads has been considered in many cases a matter of too great an expense to be seriously contemplated for the great trunk lines of the country on account of the cost of keeping the large power plants in operation, there are ample possibilities for the electrification of railroads in such countries where there is an abundance of water power. The Scandinavian Peninsula, as is well known, is in this respect better provided than any other country in the world, Switzerland excepted, and the people of Sweden have for this reason been contemplating for some time the electrification of the main trunk lines of the government railroads. It is intended, if possible, to eliminate steam motive power entirely, or at least to eliminate it for passenger service. As the state owns a large number of water falls and exerts a large control over the remaining ones, working upon the principle that these falls are natural gifts which belong only to the nation as a whole, the electrification can be carried out with far less expense than would otherwise be the case. Some of the private railroads have already contracted for electrical equipment and installation of electric traction.

* * *

THE ERA OF HEAVY LOCOMOTIVES.

The announcement that the Erie R. R. has ordered three very heavy Mallet type articulated locomotives weighing something over 200 tons and having a tractive power of 98,000 pounds, arouses further interest in heavy freight locomotives of this type. These machines will have sixteen driving wheels, eight in each group, and the entire weight will be carried on the driving wheels, as it should be in locomotives of this type. They will be able to pull a train of 225 loaded freight cars (whatever that means) on a level track and will be used on the heavy grades of the Erie so as to permit of handling 2,000-ton trains between Jersey City and Salamanca without breaking up.

It is with much hesitation that we differ from the judgment of practical railroad men who are carrying the idea of large locomotives and heavy trains to the extreme, but there is certainly room for argument in favor of moving all freight at uniform speed irrespective of its character. It is, of course, easy to figure out that the larger the train, and the heavier the locomotive (or rather the greater its tractive power), the cheaper will be the cost of freight movement, but this idea may be carried to an absurdity. The function of a railroad is not only to transport freight but to do it with some degree of rapidity. Already the country is crying out against the slow movement of freight, especially the smaller shipments. What we need most now is acceleration of freight movement rather than of the slow movement of a great bulk in enormous single-train units. The putting into commission of extremely heavy locomotives of this type must necessarily mean greatly increased stresses on the roadbed and bridges, for while it is possible that the distribution of weight can be so effected as to keep within the present wheel loads of the ordinary heavy locomotive type, it is not possible to avoid dangerous concentration of weight within a locomotive length. So unless the use of these large locomotives means freight acceleration as well as economical movement we shall be doubtful as to whether their extended use will be to the best interests of railways and their patrons.

* * *

CAUSE OF WRECKS ON CURVES.

The several accidents to high-speed trains on curves within the past year, notably the wreck on the London & Southwestern Railway at Salisbury, England, lead to the consideration of their cause and possible remedy. The first reason given is always high speed—but the curves are usually banked to counteract this and we are bound to consider the guiding of the engine itself by the trucks as this is supposed to be their special function.

Much has been said against the use of the pony truck for high-speed work, but it will be noticed that the most accidents have happened when there was a full truck under the front end. But this proved nothing for either truck as the fault or credit is due to conditions outside of the truck itself.

Old runners on the Lackawanna will remember how the old "original camels" had a way of going off a curve when running down hill as into the Scranton yard, and there was a reason. The drawbar between engine and tender was very low, under the ash-pan. The engine did much of the braking in those days and the cars would sometimes come bumping down against it. The drawbar was below the axle and the tendency was to raise the truck from the track which often happened until the drawbar connections were changed by Mr. Watts Cooke.

Now conditions are reversed. The train does most of the braking and holds the engine back—and in many cases the coupling between engines and tender is above the axle. When the conductor at Salisbury decided that the engine was running too fast and applied the emergency, the train suddenly dragged back the engine, lifted the trucks from the rail enough to prevent their guiding—and the rest we know. In a similar case that we know of the truck wheels were lifted so high they never marked the ties as they shot across and off at the curve—immediately after the engineer applied his brake rather heavily.

This is not a matter of theory but simply a case of leverages. Even suppose the coupling is below the center of axles, we often find the drawbar lower at the tender than on the engine. This affects it in the same way by bearing down at the back end. But leaving the braking out of the question, suppose the rear driving spring of a ten-wheel or Atlantic engine gives out, or the spring hanger breaks and the tendency is to reduce the weight on front truck. The same effect may be produced by the front driving-box sticking in the jaws, for the up-and-down-motion of the back drivers would tend to bring about the same conditions.

The remedy seems to be to so design a locomotive that, under no conditions, there can be less weight on the guiding wheels than will always keep them on the rails even on the worst curves.

The pony truck gives very little trouble if properly made because it is equalized with the drivers. In a ten-wheel or Atlantic type engine the easiest solution would seem to be to equalize the truck with the drivers so that it might always bear its share of the load. Unless a locomotive will tip forward when jacked up under the front driving axle, and none but an eight-wheeler will do this, the truck should be equalized with the front drivers if not with all. F. H. C.

THE COST ACCOUNT AND THE DRAWING ROOM.

There are probably very few draftsmen who have not, at some time or other, experienced that cooling effect on their enthusiasm which follows when the superintendent or the manager, after having looked over a new design, in one's own estimation particularly ingenious, pronounces it as "all right, but too expensive to build."

It is evident that the superintendent thinks that the draftsman has no idea of the cost of building the devices he designs. This may be true to a certain extent, but if a critical view is taken of the question, the draftsman is perhaps the one least to blame for this unfortunate condition.

The cost department in most of our large establishments is conducted, one might say, on a purely confidential basis. The cost of the tools or devices made, the cost of the manufactured product, and the margin of profit is considered as a secret not concerning anybody but the higher officials of the concern. While this may be a perfectly proper attitude from a certain point of view, it places the men who are supposed to design the new devices by which the production is to be increased, and the cost decreased, in a very difficult and undesirable position.

The designer or draftsman who is called upon to perfect the method for doing a certain operation will evidently try to devise a scheme as nearly perfect as his ability permits. The device or the machine which is the result of his work may be a very costly one, but it may cut down the cost of production so materially as to be a cheap improvement when used for a sufficiently long time. However, it may be that the device is to be used for the manufacture of a certain article which is not sold in any great quantities, nor at any considerable margin of profit. In such a case, the new proposition may be one extremely costly. But the draftsman cannot be expected to judge as to the relative cost of the design, unless he is permitted to inform himself upon the questions determining the advisability of going into great expenses. This is, however, in many cases denied him, and when he is sufficiently interested in the success of the work assigned to him to try to find out for himself, it is not unusual that he is made to understand that the business of the cost department is not within his territory.

The result, of course, is that the designer puts his best efforts in perfecting a device which is afterward to be pronounced as too expensive. It is, however, poor policy to determine upon the cost of a device after it is designed. It would be far better if the designer, before starting to put his ideas on paper, were given the opportunity to form a clear conception of the commercial results to be accomplished. This can be done only by permitting him to find out to what expense he may consistently go in his design, and this expense depends primarily upon all the little facts of present cost and margin of profit and the amount sold of the article produced.

By opening the way to such information to the designer, a great amount of uselessly spent energy could be used for better purposes. Knowing that the saving on a certain operation in the shop could be but a trifle, no matter how perfect the tools used might be, no time would be wasted on the invention of costly machines for the performance of such an operation. But on the other hand, in a case where the saving would be very considerable, and the production of the article so great that a very expensive device would be warranted, provided it were efficient, in such a case the designer would know that here was an opportunity for him to let the whole of his ingenuity come to the front. He would not feel deterred from doing his best, fearing that he would turn out something "too expensive."

While it would be indicative of poor business judgment to advocate that the accounts of the cost department should be open to whosoever wished to pry into its secrets, it may not be an uncalled for suggestion to point out that better results could in many cases be obtained, if such men, upon whom the development of the paying qualities of the shop largely depend, were not denied such information as would materially help them to satisfactorily solve the problems of decreasing the cost of production.

THE SECOND-CLASS POSTAL RATE AGITATION.

The present agitation by the United States post-office officials to increase the second-class postage rate which now applies to periodicals has brought forth a remarkable proposal from Mr. W. D. Boyce of Chicago. It cannot be supposed that the proposal is made with the expectation of its being accepted, and it must, therefore, be regarded largely in the nature of a gigantic "bluff," but nevertheless it is of interest, especially at this time, when the second-class rate is being so warmly discussed. Mr. Boyce proposes that the United States government turn the post-office business over to a $50,000,000 private corporation under full government regulation. In return he promises to reduce all postal rates one-half; to establish rural postal express; to pay full rental into the government treasury for all post-office quarters; to charge the government regular rates for its postal business; and to turn over to the government all profits above 7 per cent of capital invested. Mr. Boyce is a Chicago publisher and supposedly has intimate knowledge of the conditions of post-office working and of the enormous business due to second-class mail matter.

To effect this undertaking he would, in the first place, cut out all sinecures, which means that the political postmaster who draws a big salary and pays a deputy for attending to his work would get short shrift. The most important feature of the plan outlined, however, is putting the business on an equitable basis as to railway transportation. The business would first of all be put in charge of a railroad traffic manager, and some of the large juicy plums now going to certain railways for transportation for postal matter would be cut off. He estimates that the expenditure for railroad haulage could be cut down from $50,000,000 annually to about one-half that sum. It is also pointed out that one reason for the present inefficiency of postal management is that nine different postmaster-generals have occupied the position during twenty years. This of course is in keeping with our absurd system of political rotation in office, which formerly obtained in all grades of government employ, but it is not in keeping with good business methods. We can scarcely conceive of any successful business man who would change his general manager on an average of once in two years. A business that could succeed in spite of such adverse conditions must be something of the nature of a natural monopoly or one in which the management cut very little figure.

Most opponents of an increase of rate on second-class matter recognize the presumable fact that under *present* conditions the carrying of this class is done at a loss, but to offset this there is no question but that the carrying of second class matter is responsible for an enormous number of letters in direct response to advertising or other features incident to the business of a publication. All letters, of course, are subject to the first-class rate and this is highly profitable. It is a moot question whether the government would not lose largely by extinguishing a large quantity of second-class publications (as would undoubtedly result with a large increase in postal rate), because of the loss of first-class postal matter.

The present agitation may happily result in the reorganization of our postal system on sound economic principles and the elimination of useless expense and leaks which now no doubt are fully as much responsible for the present enormous annual deficit of something like $7,000,000 or $8,000,000 yearly as the so-called second-class privilege which is extended to publishers only.

* * *

A man, like a battleship, is supported by his own displacement; and, if he is to hold his own in the battle of life, with freeboard enough for winter weather, he must have a high box coefficient. His only foundation on the sea of life is his power of displacement. A man, when launched into the world, finds no empty place made ready to receive him. No one scoops out a hole in the water to receive the ship; when launched she must displace her weight of the element into which she plunges. So a man displaces his weight of whatever element is opposed to him.—*Extract from paper, "The Man and the Ship," read by Mr. George W. Dickie before the Technical Society of the Pacific Coast, March* 3, 1905.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

It is stated in the *Times Engineering Supplement* that deposits of vanadium have been found in Peru. A syndicate of Pittsburg capitalists is reported to have obtained a concession from the Peruvian government for working the deposits.

According to the *Practical Engineer* the best efficiency in turbines is obtained by using Francis turbines for heads not considerably exceeding 300 feet, and Pelton wheels for heads between 175 and 1,600 feet.

An indication of what may become the common attitude of large cities as to steam locomotives is that of the District of Columbia. The commissioners of the district have announced that when the new Union Station is completed no steam locomotives will be allowed on any of the railroads within the city limits. All locomotives drawing trains must, therefore, be electric, compressed air, or some type in which there is no obnoxious combustion of fuel.

Last November the new Japanese battleship *Satsuma* was successfully launched from the Yokosuka Dockyard. This vessel, which is the only one afloat comparable with the English *Dreadnaught* has been designed and constructed exclusively by Japanese engineers. The armorplate, as well as the guns, have been produced in Japan, and in fact the Japanese have demonstrated to the world that they have become entirely independent of the Western hemisphere even in the field of highly specialized engineering. The vessel has a displacement of 19,200 tons.

In the operation of air compressors the best results are obtained, it is said, when the areas of the suction and discharge valves are equal and of such proportions that the velocity of the air does not exceed 5,500 feet per minute. On a compressor run with a piston speed of 550 feet per minute, this requires a valve area equal to 10 per cent of the piston area. The practice of making suction valve areas larger than those of the discharge valves is not advised as, while the incoming air is of greater volume, the discharge valves remain open for a very small proportion of the stroke.—*Engineering Record.*

The McKeesport plant of the National Tube Co. are now making and shipping pipe in 40-foot lengths. The use of long pipe is desirable, of course, on account of reducing the number of joints and the liability of leakage; the less number of joints also materially reduces the labor of installation. For these reasons the long lengths of pipes are being used in extensive pipe installations such as refrigerator plants, pneumatic and hydraulic pipe lines, etc. The 40-foot pipe is made in 1 to 3-inch sizes, standard and extra strength, but as yet no galvanized pipe of this length is made.

In an address on large gas engines at the Engineering and Machinery Exhibition at London, Mr. H. A. Humphrey stated that under favorable working conditions a large gas engine may develop a horsepower hour for 0.8 pound of coal, while a steam engine would require two pounds to develop the same power. He also said that he had information to the effect that the use of gas engines in rolling mills had reduced the cost of the finished product about $3.00 to $4.50 per ton. The large gas engine has had great success on the European Continent where coal is more expensive than in England and the United States.

According to *Chambers' Journal* the Niagara Electro Chemical Co. has recently introduced a new product named oxone. This is made from a specially prepared form of sodium peroxide. Its value lies in its power of giving out free oxygen in the presence of carbonic acid gas and water. By this means air in confined spaces may be kept furnished and supplied with oxygen for breathing purposes for an indefinite period provided, of course, that the carbon dioxide is absorbed in the process. This product promises to be of great service in mining, as miners equipped with oxone will be able to go into drives or slopes without the present evil effects. It also should be greatly serviceable in submarine boats.

Tests made (in 1904, continuing to 1906) by Messrs. Howe and Harrington at the Worcester Polytechnic Institute, to determine the specific heat of fire-brick gave, as might be expected, varying specific heats in the temperature range 0 to 1,100 degrees C. (32 to 2,012 degrees F.) From 0 to 100 degrees C. (32 to 212 degrees F.) the specific heat was 0.221; from 500 to 600 degrees C. (932 to 1,112 degrees F.) it was 0.251; and from 1,000 to 1,100 degrees C. (1,832 to 2,012 degrees F.) 0.281. Only one kind of fire-brick was tested, but it is not thought probable that other kinds will differ widely in their specific heats. The precise determination of the specific heat of fire-brick is of value in figuring the heat absorptive value of boiler settings, etc.

The cohesion and tenacity of concrete structures has been amply demonstrated in a case of a building o. reinforced concrete in Tunis, Africa. The building itself is five stories high and is constructed entirely of reinforced concrete. When nearly completed the foundation on one side settled to such an extent that the building slowly sunk on this side until the walls formed an angle of 25 degrees with the vertical line. By excavating the foundation and counterloading the floors on the opposite side of the building it was restored to a level position without any injury whatever to the structure itself. The possibility of doing this proves the presence of qualities of enormous endurance in buildings of reinforced concrete, presenting as they do a single solid structural unit.

We have of late referred several times to the possibilities for windmills, but have not called attention to the fact that there are at present windmills designed in rather large units. According to *Power*, one mill developing 50 horsepower was erected as an experiment in Golden Gate Park, San Francisco, for pumping water. This windmill fulfilled all expectations so well and proved so economical that another is being built. It is claimed that several thousand dollars per year are saved by this windmill, comparing the expense with that of other motive power. Apart from the pumping machinery, such a mill can be built for less than $1,500. In Holland windmills 50 feet in diameter and developing from 40 to 60 horsepower in good wind are not unusual, and are used not only for pumping purposes but for driving grist-mills, saw-mills, and many other kinds of small industrial plants.

The following empirical rules are suggested by Mr. Dugald Clerk for approximating the power of gas engines. For engines not exceeding 12 H. P.:

$$\text{H. P.} = \frac{D^2 \times N}{3}$$

and for engines exceeding 12 H. P.:

$$\text{H. P.} = \frac{D^2 \times N}{2.4}$$

in which

D = diameter of cylinders, in inches.

N = number of cylinders.

These formulas are based on the assumption that an average of about 70 pounds mean effective pressure and a piston speed of 800 feet apply to engines not exceeding 12 H. P.; and 70 pounds mean effective pressure and 1,000 feet to engines exceeding 12 H. P.

The longest concrete arch yet undertaken anywhere is that of the main span of the Walnut Lane bridge in Philadelphia. Not only is it the largest of its class, but it has the third place in the list of long-span arches of all classes of masonry, so that the structure must be regarded as one of the most

interesting engineering undertakings of to-day. The longest masonry bridge in the world is the structure at Plauen, Saxony; it has a clear span of 295.2 feet. The second place is held by the bridge over the Petrusse River in Luxemburg; it has a span of 275.5 feet and a rise of 101.8 feet. The third place is held by the Walnut Lane span of 233 feet. The fourth place is occupied by the Gruenwald bridge over the Isar River at Munich, which has a reinforced concrete span of 230 feet and a rise of 42 feet. The famous Cabin John bridge near Washington has now dropped back to fifth place. It is not at all improbable, however, that this list will see some important additions before many years have elapsed, for the construction of longspan reinforced concrete arches has not yet begun. The 230 feet of the Gruenwald bridge, the longest concrete structure with metal reinforcement, is of insignificant length when measured by the possibilities afforded by new methods of design.—*Engineering Record.*

An interesting comparison between steam turbines and reciprocating engines in regard to their dimensions and the space occupied is given in the *International Marine Engineering.* The comparison is made between the cruiser *Salem*, fitted with steam turbines, and the battleship *Vermont*, fitted with triple expansion reciprocating engines. The comparison is direct, inasmuch as the requirements are for about 8,000 horsepower in each case. The dimensions, as given, are as follows:

	Turbine.	Engine.
Length over all........	16 ft. 2¾ ins.	33 ft. 6½ ins.
Width over all........	13 ft. 6 ins.	11 ft. 3 ins.
Height over all........	12 ft. 6 ins.	21 ft. 9 ins.
Floor space............	219 sq. feet.	377 sq. feet.
End area..............	169 sq. feet.	245 sq. feet.
Side area, or target....	203 sq. feet.	730 sq. feet.
Over all volume........	2,735 cu. feet	8,200 cu. feet.

In the above tables the areas and volumes are figured out from the gross dimensions in each case, and are, therefore, strictly comparable. The turbine shaft over all measures 23 feet 7 inches, while the crankshaft of the engine is 31 feet 1 inch. The length from center to center of main bearings of the turbine is 18 feet 6 inches, corresponding to 25 feet 8½ inches from center to center of main bearings of the engine. The length over the stuffing boxes of the turbine is 14 feet 5½ inches. The length over all of the cylinders of the engine is 32 feet 9 inches. In the table the figures for the turbine are based on the over-all dimensions of the casing.

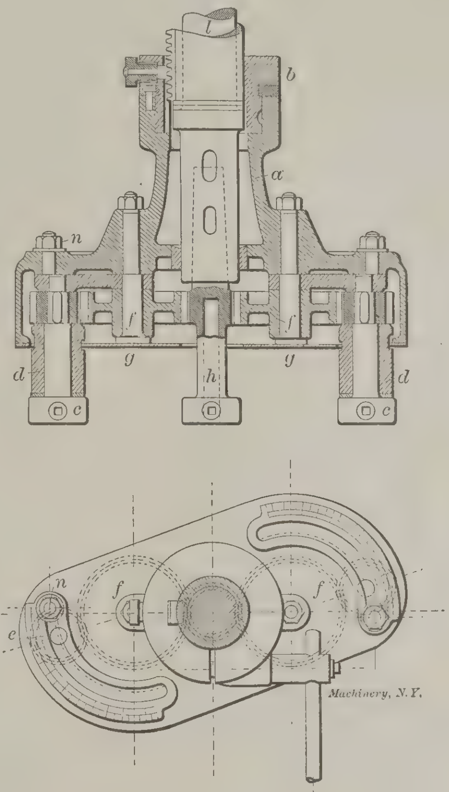
LEAKAGE IN COMPRESSED AIR PLANTS.

Some statements in *Compressed Air* in regard to the cost of leakage in compressed air plants are well worth consideration. Few people realize that leakage plays an important part in the efficient operation of a compressed air plant. Many concerns will go to great expense in installing high class air compressors with compound steam cylinders and two stage air cylinders, but when it comes to installing the pipe line the utmost carelessness is displayed, the same fittings being used that would apply to a steam line without the fact being taken into consideration that steam and air are two very different mediums. The heat of the steam tends, of its own accord, to keep joints tight which, if cold, would leak considerably. In manufacturing establishments, particularly, with a compressed air plant with a capacity of, say, about 500 cubic feet per minute, where the air plant is of a more incidental character than in the case of a central air power plant, the percentage of leakage is usually very high owing to the fact that less pains are taken in the installation of machinery and piping in smaller and cheaper plants than is the case with the larger and more expensive ones. Furthermore, most manufacturing establishments require a more complicated distribution of the compressed air and the installation of more valves, bends and outlets is needed. It is fair to consider the leakage as being 2 per cent in a manufacturing plant. The compressor will very likely be a single stage one and the horsepower required to compress the leakage of 10 cubic feet per minute to 100 pounds pressure will be $0.207 \times 10 = 2.07$. At 2 cents per horsepower per hour this leakage would cost 41.4 cents per ten hour day, or $124.20 per year.

THREE-SPINDLE DRILL HEAD.

Very often when three holes are required to be drilled in a line, they are spaced equidistant. In such a case a simpler arrangement than that of the ordinary multispindle drill for drilling all the holes at once can be devised. Such an arrangement is shown in *The Practical Engineer*, issue of November 16.

The sectional elevation and plan of the device show the general arrangement. The bushing *b* is mounted on the spindle sleeve of a drilling machine, and is held in position by means of a bolt tightened against the rack. On this bushing



Three-spindle Drill Head

the housing *a* is secured in such a manner that it can be turned round, and thus the drills adjusted to suit the work. The housing *a* can be firmly clamped on the bushing *b* in any desired position.

The driving of both adjustable spindles *c* is effected through the intermediate pinions *f*, meshing into the toothed chuck *h*, which is inserted in the lower end of the spindle *l*. The spindles *c*, with their bearings *d*, engage with the bolts *g*, and can be swung round these and thus be quickly and accurately adjusted, and be fixed in position by nuts *n* to the required pitch of holes by means of dials attached to the housing.

TIN LEAD ALLOYS AS SOLDERS.

The Iowa Engineer, September, 1906.

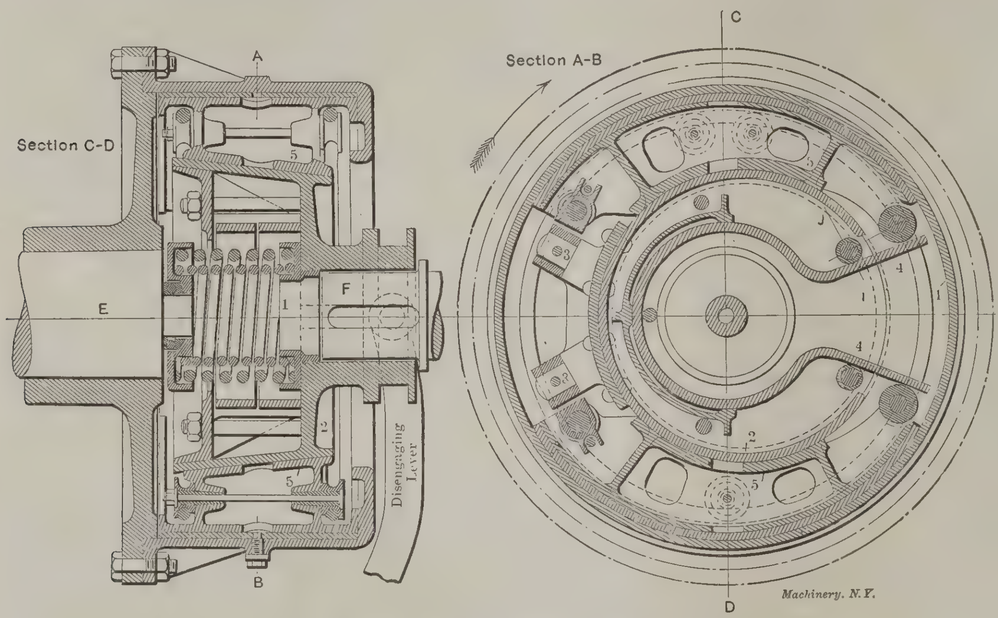
The properties of tin lead alloys used as solders have not been very extensively investigated, although their use is universal. For this reason experiments were made at the Iowa State College in order to ascertain which would be the most preferable method of making soldered joints, as well as their tensile strength. As to the methods of making soldered joints it was found that any pressure whatever upon the solder at the moment of setting greatly reduced the strength of the joint. When making a soldered joint, therefore, the upper piece should be supported above the lower one, the solder be fused by means of two blow torches and the pieces brought together with very gentle pressure. This method differs from the most common one or that of "sweating." In regard to the strength of soldered joints, it was found that the time element made a decided difference in the tests, and could not be eliminated. For instance, a decrease of 5 seconds in the total time of testing increased the strength 4,000 or 5,000 pounds per square inch, the total time of testing being from 20 to 25 seconds. The maximum strength obtained under

any circumstances was 25,900 pounds per square inch with a joint on copper with solder containing 60 per cent tin. The total time of this test was 20 seconds. As to the influence of the amount of tin in the solder the tests showed that the maximum strength increases with a percentage of tin, but if the time element is considered, the average strength increases only up to 60 per cent of tin and then decreases. For this reason 60 per cent of tin in the solder must be considered as most suitable for general work, but for work requiring little mechanical strength, such as "sealing," a lower percentage of tin might be used.

GRADUAL APPLICATION CLUTCH.

Attention is called by *Engineering* to a gradual application clutch, known as the Michel grip clutch, designed by a French engineer.

On the end of the shaft *E* is keyed a flange, to which is bolted a cylindrical casing, forming the exterior of the clutch. The sliding portion of the clutch keyed to the shaft *F* consists of a male cone, marked 2 in the cut, eccentric to the line of the shafts, and having a portion of one side cut away. In the interior of the cone is a curved plate-spring with the ends projecting through the opening, and constrained by two fixed stops just inside the cone. On the back of the cone, opposite the opening, is riveted a bracket, carrying two pins, marked 3, and surrounding each pin is a buffer, fastened to it by a taper pin. In the space on each side of the cone, between it and the casing, is a curved tapered shoe. These shoes carry buffers at their larger ends, opposite the cone-buffers just mentioned, and round collars, surrounding pins at the smaller ends of the shoes, act also as buffers against the ends of the plate spring. Pins with grooved collars at each end are fastened through the centers of the shoes, two through one shoe and one through the other. These are shown in side elevation and dotted in the section *A B*. A spring-ring passes round the grooves in the collars, and holds the shoes against the cone.



Michel Gradual Application Clutch.

The action of the clutch is as follows: When the disengaging lever is relieved, the helical springs, shown in section *C D* force the cone home against the inner faces of the shoes, and the latter are pushed outward in contact with the casing. If the casing is revolving in the direction of the arrow, as soon as the shoes come in contact with it, the upper one tends to be drawn into a narrower portion of the annular space against the action of the plate spring. It is thus tightened between the cone and the casing until there is sufficient friction to transmit the drive. The lower shoe, on the contrary, is loosened and pushed back against the cone buffer, so that it takes no part in the transmission of power. It is clear that if the revolution of the casing were in the other direction, the drive would be equally efficient, the lower shoe then transmitting the power.

TRADE SCHOOLS IN SWEDEN.

At the same time as the question regarding efficient trade schools is coming to the front in this country it has received a great deal of attention everywhere in Europe. According to *Teknisk Tidskrift* the city council of Stockholm, Sweden, is contemplating a system of completely organized trade education, the main features of which may be of interest wherever this question is considered.

The school contemplated for the mechanical trade would require the pupils to attend all the six days in the week for four years, the total number of hours per week being 50 for the two first and 54 for the two last years in the course. The practical work in special shops provided would occupy 32 hours during the two first years and 42 hours a week during the two last years. The remaining hours would be given up to studies on subjects connected with the trade. These subjects would be free hand and mechanical drawing, fundamental mathematics and the elements of mechanics, calculations of areas and weights, the first principles of machine design and subjects of general nature connected with mechanical work. The requirements for entering these trade schools are to be a complete grammar school course. For persons that have already entered in industrial work a course will be provided where attendance will be expected only one day a week. In this course the subjects will be exclusively theoretical, since the pupils will get a practical training during the five days in the week during which they engage in the trade. It must, of course, be expected that employers will realize the necessity, as well as the advantage to themselves, of this trade education so that there will be no difficulties in regard to setting apart one day for educational purposes. Should difficulties arise it is likely that the government will duly assert its influence in behalf of the young men looking for more complete education in the trade. The shops are to be equipped as modern and complete as possible. Only men of practical ability who have been a long time actually engaged in industrial pursuits will be engaged as instructors. This will insure that the schools will give instruction of an equally up-to-date nature as what could be obtained from actual experience in manufacturing establishments. The cost for establishing schools for the various trades is estimated to be about $350,000 and the yearly maintenance to about $35,000. The city authorities as well as the national government of the country will provide the means necessary. When in complete condition the schools will probably provide for about 500 students attending the daily courses and 1,200 additional attending the courses where instruction is given only one day a week. In order to insure earnestness of purpose of the students who enroll and add to their desire to follow up this purpose a fee of about $5.00 per year will be charged. This is not so much for the purpose of providing any income to the schools as to inculcate the idea of the value of the instruction, inasmuch as things that can be had for nothing as a rule are valued less than those for which a payment is required, even if this payment is only nominal.

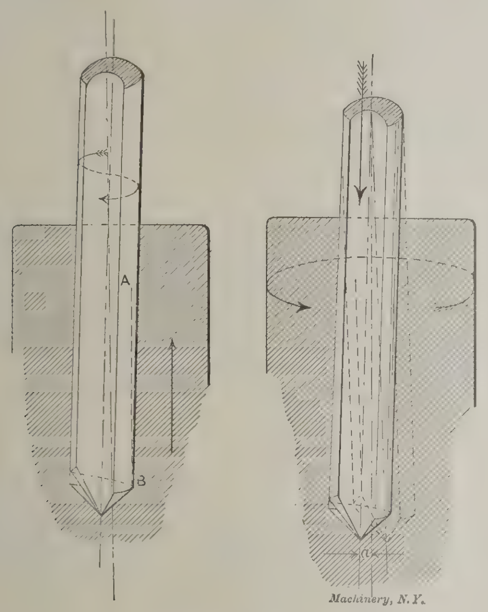
THE DRILLING OF DEEP HOLES.

The *Zeitschrift für Werkzeugmaschinen und Werkzeuge* gives an account of the drilling and boring of a hole 4¾ inches in diameter, through a shaft 147½ feet long. The principles governing the drilling and boring of deep holes are discussed, and are summarized in the following:

The difficulties to be overcome in producing deep drilled holes can be classified in three groups. In the first place the

drill has a great tendency to run out, thus producing a hole that is neither straight, nor uniform in diameter; in the second place great difficulties are encountered in trying to remove the chips in a satisfactory manner, and in the third place the heating of the cutting tool is difficult to prevent.

The principle involved in common drill presses where the drill is given a rotary motion simultaneously with the forward motion for feeding is the one least adapted to produce a straight and true hole. Better results are obtained by giving only a rotary motion to the drill, and feeding the work toward it. It has been found, however, that for drilling deep holes the reversal of this, that is, imparting a rotary motion



Drilling of Deep Holes.

to the work, and the feed motion to the drill will answer the purpose still better. It seems as if there could be no material difference between the latter two methods. An analysis of the conditions involved will show, however, that there is a decided difference in the action of the drill. If the drill rotates, and the work is fed forward as shown to the left in the cut, the drill when deviating from its true course will be caused to increase its deviation still more, by the wedge action of the part *B*, which tends to move in the direction *A B* when the work is fed forward. In the case of the work rotating and the drill being fed forward, as shown to the right in the cut, the point of the drill when not running true will be carried around by the work in a circle with the radius *a*, thus tending to bend the drill in various directions. The drill is by this action forced back into the course of "least resistance," as it is evident that the bending action, being exerted on the drill in all directions, will tend to carry the point back to the axis of the work where no bending action will appear. The chips, as is well known, are carried off by forcing a fluid into the hole, which upon its return carries with it the chips. This fluid being oil will serve the double purpose of carrying away the chips and lubricating the cutting tool, keeping it at a normal temperature.

THE WEIGHT OF A CROWD PER SQUARE FOOT.

From *Engineering*, September 21, 1906.

To the structural engineer the possible normal weight of a crowd of people is an important factor of calculation. The prevalent custom has been to accept as a basis the recommendations of Trautwine, who advanced the theory that on bridges for turnpikes and common roads no probable contingency could crowd people to such an extent as to weigh more than 80 pounds per square foot of floor and that this might safely be taken as the maximum load on spans of 20 feet or more. To compensate, however, for impact, he recommended to adopt 100 pounds as the limit for crowds. In engineering practice both in this country and America this formula is more or less accepted. Trautwine refers in substantiating this theory to a test made by a Mr. Nash who wedged as closely together as possible a group of men within a 20-foot diameter, the last man admitted being lowered down from above. In this extreme case a result of 120 pounds per square foot was obtained. But this weight has since been exceeded by a number of experimenters, notably by Prof. Johnson of Harvard, who, in 1904 obtained a weight of 164.9 pounds per square foot. When these results were published they caused considerable comment, by some American engineers in particular. Prof. Johnson therefore undertook to see exactly what the limit was.

A wooden compartment or pen 6 feet by 6 feet was constructed, placed on the ground securely braced to the walls of a building and furnished with a door which could be closed by a strong wooden bar. Various photographs were taken at different degrees of compactness from above. One hundred pounds was easily obtained without any discomfort to the men; 154.2 pounds per square foot was easily reached by 37 men who arranged themselves as they saw fit. Finally 40 men of more than average weight were forced within the area of 36 square feet and a final test gave a load of 183.3 pounds per square foot. This result is additionally remarkable from the fact that though tightly packed the 40 men experienced no serious discomfort and could move their limbs with little difficulty. The only distress which was met with was that suffered when they all tried to breath deeply at the same time. It is evident from Prof. Johnston's investigations that a weight of 140 pounds per square foot is quite feasible where there are throngs of people all headed one way, while a load of 80 pounds per square foot is quite a common thing in buildings and private houses where social gatherings are frequent.

LOADING OF ROPE.

A little taste of elementary mechanics is sometimes worth while. We must not forget that while the action of all mechanisms is controlled by simple principles, these principles are not always as well understood as they should be by men who have the handling and care of property worth many thousands of dollars, to say nothing of the danger to human life caused by seemingly inexcusable ignorance. These remarks apply with special force to the handling of material by cranes or derricks, using ropes and sheave blocks. A careless workman may see a load of several tons handled safely

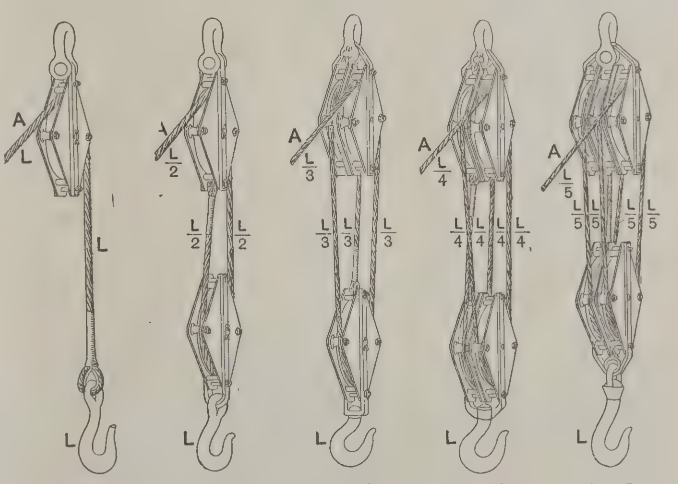


Fig. 1 Full load on rope · Fig. 2 Strain on rope is one-half the load · Fig. 3 Strain on rope is one-third the load · Fig. 4 Strain on rope is one-fourth the load · Fig. 5 Strain on rope is one-fifth the load

Machinery, N.Y.

with pulley blocks and a wire rope of perhaps not more than ½ inch diameter. The construction of the pulley blocks which permit of such a load being safely handled of course comprises a number of sheaves in both a stationary and moving block which divide the load among several ropes. For example, the accompanying cut taken from the *American Wire Rope News* (with a slight change) illustrates the conditions in loading on a rope with pulley blocks. The first figure shows that with one block the total load on the hook is transmitted to the rope at *A* but in Fig. 2 only half the load is so transmitted, and progressively up to Fig. 5 we find that only one-fifth of the load on the hook is carried by the rope at *A*. So supposing that the tackle will safely carry ten tons on the hook it by no means follows that the wire rope

alone will carry that load. On the contrary the chances are that it would not sustain it at all unless a high factor of safety was employed. The cuts show graphically the division of loading among the sheave ropes, being respectively $\frac{L}{2}$, $\frac{L}{3}$, $\frac{L}{4}$, and $\frac{L}{5}$.

THE LENTZ REVERSING MECHANISM.

A few months ago the *Zeitschrift des Vereines Deutscher Ingenieure* described the simple but ingenious Lentz reversing mechanism. Fig. 1 shows the general arrangement of the design, and in Fig. 2 a section of the detail which is particularly novel is given.

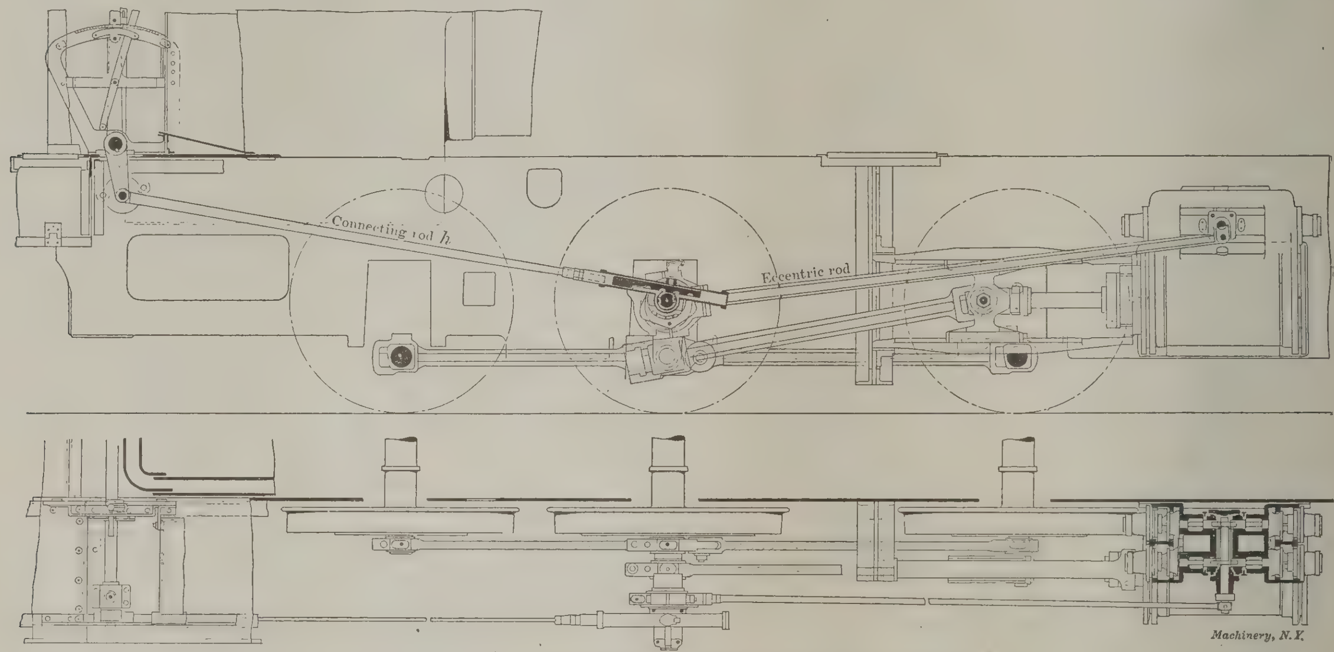


Fig. 1. General Arrangement of the Lentz Reversing Mechanism.

As seen from the cut, the crankpin is provided with an outside extension which carries a stud f. On this stud the eccentric a is mounted, and is free to move around the stud as a center. A bushing b is movable along the stud c, which is located in line with the wheel axle. This bushing is keyed to the stud by means of the key d, and will thus rotate with the wheels. The bushing is provided with spiral teeth on the outside, which mesh with teeth in the eccentric a. It is evident that a longitudinal movement of the bushing b will move the eccentric around the stud f. On the outside of the bushing b there is a second bushing e which is keyed to the final cover k, and is stationary in regard to the rotary motion of the bushing b, but moves with this latter bushing in a longitudinal direction by means of four flanges, g, on the outside surface.

This second bushing is in its turn provided with spiral teeth on the outside, which mesh with teeth in the rod h, connected with the regular reversing lever. It is now evident that a motion of the rod h in its longitudinal direction will cause the bushing e, and at the same time the bushing b, to move. The movement of the latter bushing, however, turns the eccentric around its support, and places it in any desired position. The valves themselves are operated by a horizontal shaft, turned by a small crank connected with the eccentric rod. The advantages claimed for this design are the comparatively small number of parts, and the possibility of making the mechanism perfectly dustproof. This construction has been practically tried in Germany in at least two instances, and proven to work entirely satisfactory. It is known as the Lentz reversing mechanism.

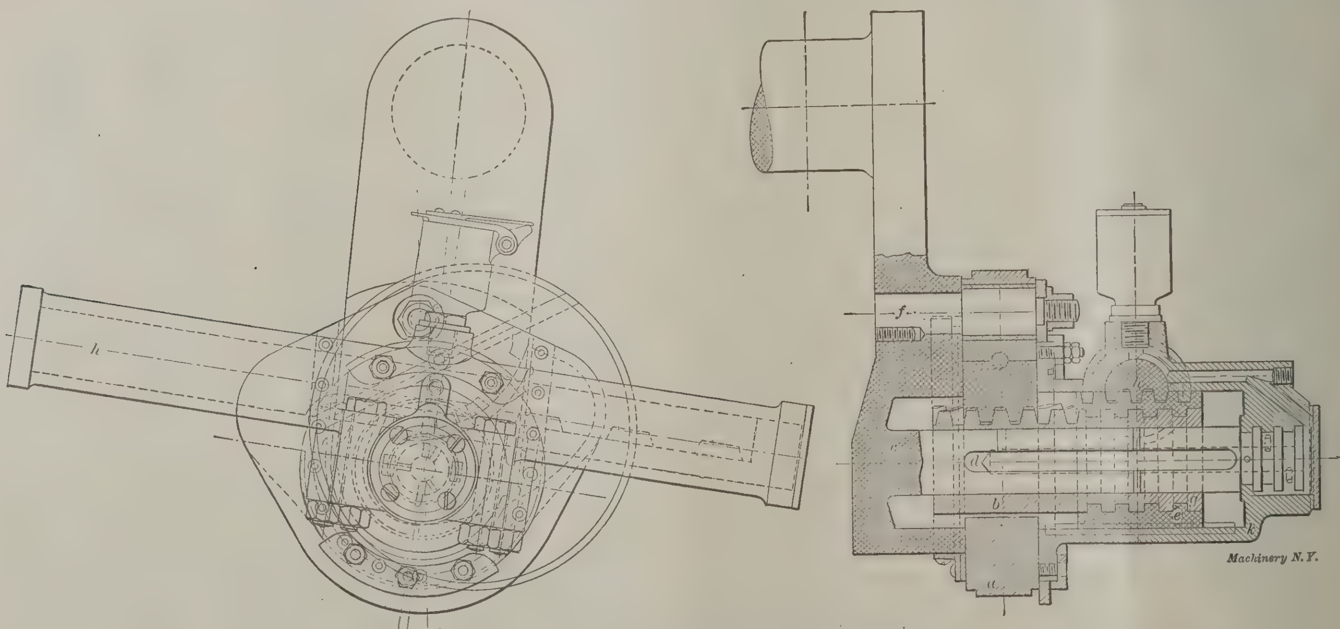


Fig. 2. Section and Side View of the Lentz Reversing Mechanism.

THE UNITED STATES CENSUS OF MANUFACTURES, 1905.

Bulletin 57, Department of Commerce and Labor

A few statistical figures from the latest bulletin of the Department of Commerce and Labor are of interest on account of the conclusions which can be drawn in regard to the in-

crease of the manufacturing in the United States during the last five years. The number of establishments in 1905 had increased by 4.2 per cent, the capital invested by 41.3 per cent, and the value of the products by 29.7 per cent, as compared with 1900. It will be noted that the value of the product had not increased in the same ratio as the invested capital, a fact which seems to point out that the large modern industrial establishments are not of necessity more productive than the smaller ones of former years. This conclusion is also borne out by a number of other statistical figures contained in the bulletin, particularly in reference to concerns of the corporation class, inasmuch as the figures given show that the large incorporated companies do not produce as much in proportion to the large capital investment as do the smaller firms and individual concerns. Thus 82.8 per cent of all the capital invested in industrial establishments comes on the corporations' share, but the value of the products of these same corporations is only 73.7 per cent of the total value of all manufactured goods. On the other hand, the firms with 9.4 per cent of the total capital produced 14.4 per cent of the total value of products, and individual concerns with only 7.6 of the capital produced 11.5 per cent of the total. This seems to indicate that the greater saving of expenses which was claimed to be incident to the large corporations is fictitious. In fact it is so much more a proof of the failure of the corporations as compared with some individual concerns as the figures do not show the unfeasibility of the large concern as such, but merely the unproductivity of establishments in corporate form. This statement is borne out by the fact that 1,899 concerns with an output valued at a million dollars or more each and controlling a capital of 37.7 per cent of the total, show value of the product of 38 per cent of the total. This seems to indicate that it is not the large concern as such which meets with difficulties, but it is the large concern when not individually conducted, but conducted as a corporation. The figures, however, show the greatest productivity in proportion to the invested capital for concerns the value of whose annual output does not exceed $20,000.

The average number of wage-earners employed during 1905 was 5,470,321 as compared with 4,715,023 in 1900. The increase of wage earners is thus proportionally far smaller than the increase of the value of the product which shows the tendency of modern machinery to displace manual labor, not by eliminating it but by making possible a larger per capita output. The greatest number of wage earners employed at any one time during 1905 was 7,017,138 and the least 4,599,091. This seems to indicate that a great number of people can secure only very unsteady employment, and that the modern manufacturing methods are augmenting the problem of the unemployed. The average number of children employed were 159,899, as compared with 161,276 in 1900, or a decrease of less than 1 per cent. Pennsylvania ranks first and Massachusetts second in the number of children employed. The greatest numbers in both of these states are shown for the textile industries. In regard to wages paid, these show an increase over the figures of 1900 very nearly in the same proportion as the increase in the value of the product.

The motive power employed in manufactures increased from 10,409,625 horsepower in 1900 to 14,464,940 horsepower in 1905, or an increase of 39 per cent, which is considerably higher than the increase in the value of the products. The statistical figures indicate that the large manufacturing plants have a tendency to remove from the large cities to rural places. While the increase of capital invested in urban establishments was 34.2 per cent, the increase for the rural plants is 58.7. In all respects the establishments located in rural districts show a higher percentage of increase than those in municipalities having a population of 8,000 inhabitants or more.

THE DEVELOPMENT OF THE FRAME OF AMERICAN FREIGHT LOCOMOTIVES.

The Railroad Gazette, October 19, 1906.

To the casual observer the frame of to-day would seem to be exactly like that of 25 years ago except in the matter of size. It consists of two bars, the upper one nearly square and the lower one of the same width as the upper, but narrower in vertical dimensions. These frames have always been made in two pieces, the back part containing the pedestals for carrying the axle boxes, and the front part rails to which the cylinders are fastened. It is the splice between these two pieces which has been the object of the study for improvement. In order to show how these details have been worked out step by step a series of illustrations are given showing the various changes in detail that have been made in the development of the fastening.

Fig. 1 is the type of fastening used in the late seventies. The frame was of wrought iron, and the front rail was joined to the main frame by a T foot whose upper arm was jumped on and held by countersunk bolts. In addition to the countersunk bolts through the pedestal, there were two vertical bolts holding the front rail to the drop of the main frame, and these bolts were supposed to be relieved of shear by the key that is shown between them. With the small cylinders in use at that time this frame gave little trouble, but with an increase in the diameter of the cylinders the repeated stresses would draw the countersunk bolts down and the nuts would come loose.

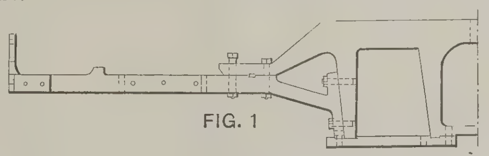


FIG. 1

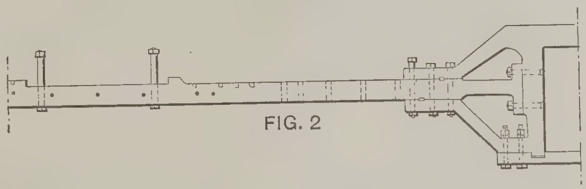


FIG. 2

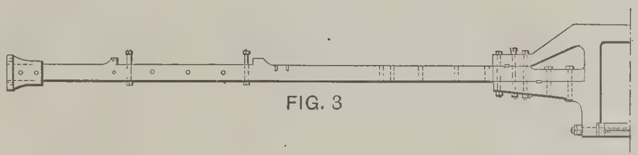


FIG. 3

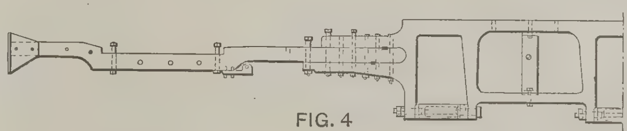


FIG. 4

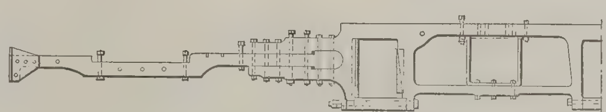


FIG. 5 *Machinery, N.Y.*

This form was followed by that shown in Fig. 2. But here the countersunk bolts joining the T foot to the main frame gave trouble by breaking, because the whole load would be carried by them in consequence of the springing of the two parts of the main frame. This construction was abandoned for that shown in Fig. 3, in which the lower portion was raised and made horizontal, with the front rail laid flat upon it and held by bolts, some of which went through the upper section of the frame, to which a key was added. This form gave excellent satisfaction, with cylinders up to 18 inches diameter. Heavier engines, however, required a stronger fastening, and a direct outgrowth of the form shown in Fig. 3 is that shown in Fig. 4, in which both upper and lower jaws of the main frame are horizontal, with the front rail between them and having a key on each side. This gave excellent service for a time, but again the increase in cylinder dimensions necessitated a change. The keys, which had but a half bearing in each of the two parts between which they were placed, would twist and throw the entire stress upon the bolts. To obviate this trouble the lower frame was given a T head, as in Fig. 5, and keyed against the lips on the arms of the main frame.

Where double rails were used they were at first attached, as shown in Fig. 6, in which the lower rail had the same T head as in Fig. 1, while the upper rail was simply laid on and bolted to an extension of the upper frame. It was the standard method of construction for many years, and the only trouble experienced with it was an occasional breaking off of a T head. When this method of fastening became too weak for the increasing diameter of cylinders, the lower arm was made horizontal, but an upward bend of the front rail still left an opportunity to use the countersunk bolt through the pedestal leg, as shown in Fig. 7. This form soon yielded to that shown in Fig. 8, in which the T head was dispensed with and the front lower rail laid on like the upper one and bolted fast. This gave way to that shown in Fig. 9, in which the upper front rail was extended back over the jaw of the forward axle, while the upper arm of the main frame was run out to abut against the cylinder casting. The lower arm was lipped up into the lower rail so as to form a bearing there for all back thrust of the cylinders. This in turn was followed by that shown in Fig. 10, in which the front upper rail was lipped down over the upper arm of the main frame, as in the case of the single rail frame of Fig. 5. Strong as this construction was, the stresses imposed by the cylinders were too great and, on the latest type of heavy engines, we find the form shown in Fig. 11 in use. Here the two front rails have been united in a single deep slab, to which the cylinders are bolted. These parts are no longer cast solid with a half saddle but are separate with a saddle between. The first frames of this sort that were built had the fastenings to the main frame as in Fig. 11, but they have been followed by that of Fig. 12, in which the upper rail has been carried back over the top of the jaws and keyed as shown.

During all this period of development there has been more or less activity in attempting to produce a cast-steel frame.

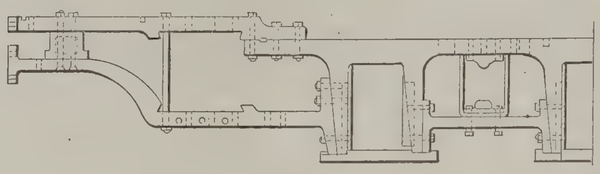


FIG. 6

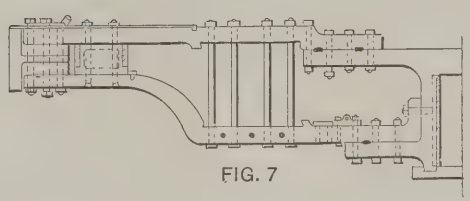


FIG. 7

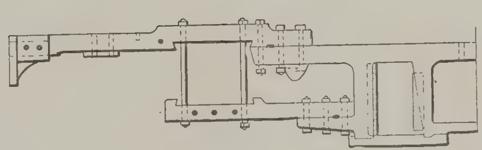


FIG. 8

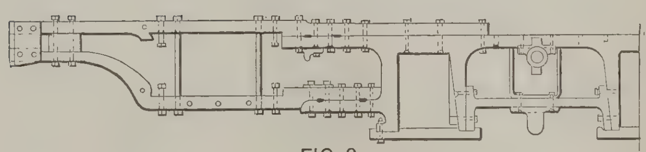


FIG. 9

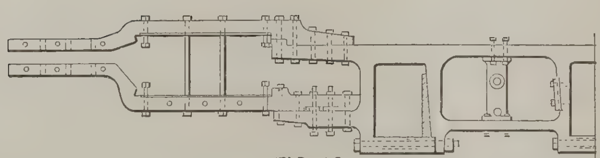


FIG. 10 *Machinery, N.Y.*

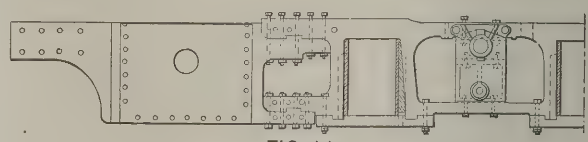


FIG. 11

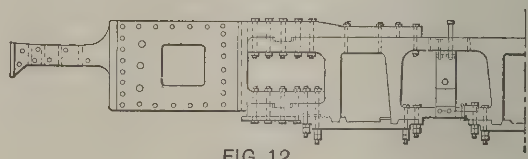


FIG. 12

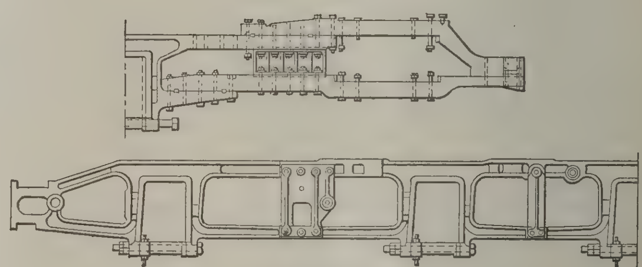


FIG. 13

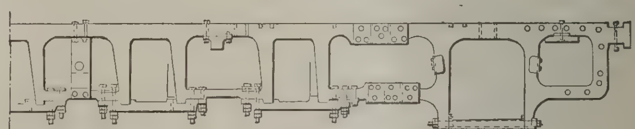


FIG. 14

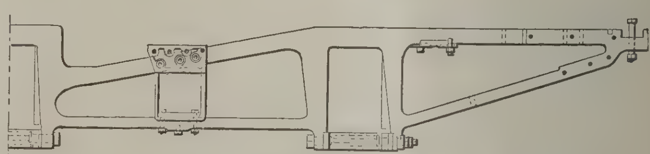


FIG. 15 *Machinery, N.Y.*

First efforts were not altogether successful, but the desirability of securing such a frame, on account of the facility with which provision could be made for the attachments, together with the probable decrease in the cost of machining encouraged makers to persist in the work until now cast-steel frames like that shown in Fig. 13 are constructed, which can be made complete for less than the cost of finishing a frame of the older type. The result is that, though these frames are far from having come into general use, they may be considered to represent the latest type of the frame of the American locomotive.

The back part of the frame has changed but little in form. That of the early engines is shown in Fig. 14, and this still holds with such modifications as may be required to accommodate the trailing truck of the later classes of engines or to add to the depth of the firebox by the use of the drop in the upper rail, as shown in Fig. 15.

The examples given show the tremendous amount of tentative work that has been required in order to develop the locomotive to its present condition, and the end is not yet.

* * *

LAKE OF QUICKSILVER! WHO CAN BEAT THIS YARN?

"A lake of quicksilver, covering an area of more than three acres and having a depth ranging from ten to fifty feet, has been discovered in the mountains of the state of Vera Cruz. The value of the product is estimated at millions. This lake has been known to the Indians for many generations. It is situated far up in the mountains in an almost inaccessible position. Its surface is partly covered by stones. It is believed that volcanic action in the mountains above smelted the quicksilver out of the cinnabar ore and that it ran down and filled this depression. A tunnel will be driven through the base of the mountain, and the quicksilver will be brought down by means of gravity."—*News Item.*

ANNUAL MEETING OF THE A. S. M. E.

The annual meeting of the American Society of Mechanical Engineers was held in New York, December 4 to 7 at the Edison Building, No. 44 West 27th Street. The registration showed that something over 1,200 members and guests were in attendance. The entertainments provided included an inspection of the Port Morris, N. Y., power house of the electrified section of the New York Central R. R., a special train being provided for the guests on the afternoon of December 6. The crowning feature was unique, being a trip to Sandy Hook proving ground by way of the Central Railroad of New Jersey. Special arrangements were made with the United States government to show the guests the various features of the fortifications and to fire a number of large guns for their edification. The annual ball at Sherry's was held Thursday night.

The New Engineering Building.

Although not yet completed at the time of the meeting, the new Engineering Building on West 39th St., between Fifth and Sixth Aves., was open for inspection, and it naturally attracted a considerable number of the members and guests.

Fig. 1. New Engineering Building, West 39th Street, New York.

These were practically unanimous in praise of its excellence of design and construction. The building is the result of a gift of $1,500,000 by Andrew Carnegie for the founding of a joint society building which would shelter a large engineering library and be the headquarters of societies accepting the gift. These are the American Society of Electrical Engineers, American Institute of Mining Engineers and American Society of Mechanical Engineers. It will also be the headquarters of a number of minor societies interested in engineering or science. These associate societies will pay rental to the holding company in the form of yearly assessments.

This building has thirteen floors above the street level, and Fig. 1, reproduced from the architect's drawings, shows a perspective view looking northwest (see MACHINERY, January, 1906.) The library, the plan of which is shown in Fig. 2, is located on the top floor to avoid the noise, dust and confusion which would be incident to location on the lower floors. The floor given up to the American Society of Mechanical Engineers is the eleventh and the accompanying plan, Fig. 3, shows the arrangement of the rooms. The auditorium, Fig. 4, which is common to all large gatherings of the societies occupying the building, is on the second floor and seats 1,000. It has a gallery and is arranged for the utmost convenience of speakers and members. It was decided that a room having a seating capacity of 1,000 was about the limit of size in which papers could be read and discussed advantageously; a larger room would cause straining of a speaker's voice and difficulty in following the discussion. The auditorium will

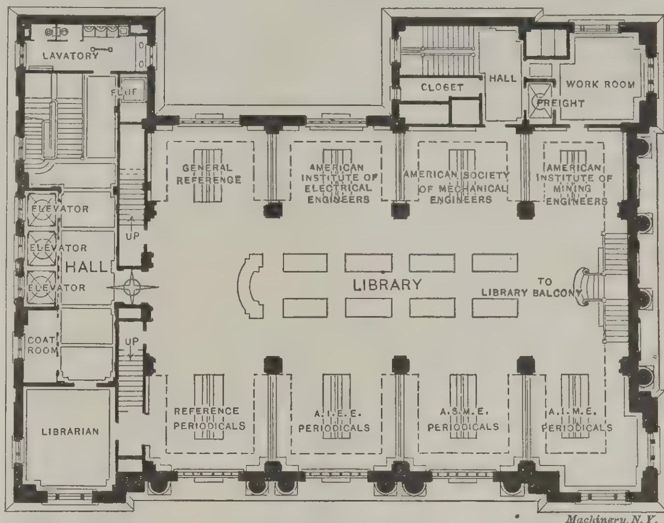


Fig. 2. Plan of Library.

hold considerably over 1,000, but the seating capacity is nominally the number given. High-speed elevators and other modern conveniences make this building a notable example of modern high-class structures. It will be a credit to all the societies connected therewith and its location only one block removed from the New York Public Library and its direct communication with the Engineering Club Building on 40th St. make a location that is ideal for convenience of research, etc. It will be easily reached from out of town, being only a short distance from the 42d St. terminal of the New York Central and New Haven Railroads and a slightly greater distance

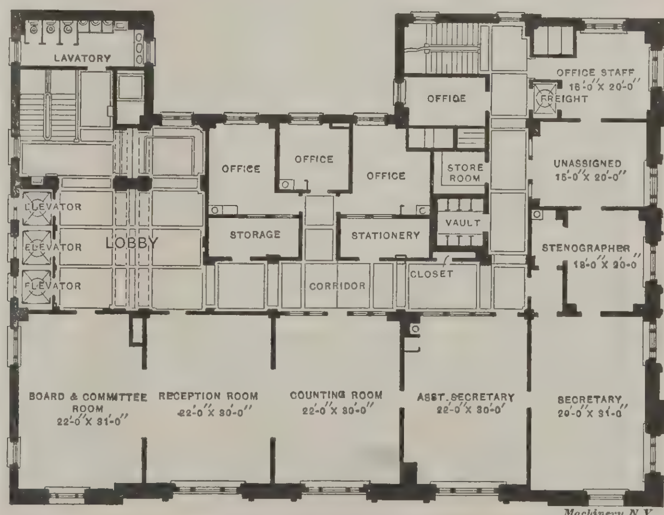


Fig. 3. Plan of A. S. M. E. Floor.

from the new Pennsylvania R. R. terminal. By the time this description appears the American Society of Mechanical Engineers will have moved into their new quarters.

REVIEW OF THE PAPERS.

On the Art of Cutting Metals, by Mr. Fred. W. Taylor.

This voluminous paper, forming the presidential address, reviews the work of Mr. Taylor and his associates in determining the elements or factors which affect the efficiency of metal-working tools on roughing cuts. These investigations have extended over a period of twenty-six years and during that time over 800,000 pounds of steel and iron have been cut into chips on experimental lathes at a cost of $150,000 to

$200,000. In carrying on this work more than ten machines were fitted up at various times and literally thousands of experiments were recorded. More than 16,000 experiments were recorded with one company, the Bethlehem Steel Co. Quite as remarkable as the result is the fact that for twenty-six years the discovered laws have been kept secret and the accumulated knowledge has been used as a lever for extending the investigations. The plan was to give to each company availing themselves of the acquired knowledge of Mr. Taylor and his associates this knowledge in return for the privilege of making more experiments at the present company's expense. The paper is very voluminous, containing about 100,000 words and twenty-four large folding sheets of halftones, drawings and tables. It is one of the most notable papers ever presented before the society and it doubtless will have a great effect on future machine tool design and practice. The investigations show that there are twelve separate and distinct elements or variables affecting the efficiency of the lathe and the same applies to any metal-working tool. A full abstract of this remarkable paper will be given in sections as space permits.

Report of the Committee of Standard Proportions of Machine Screws.

At a joint meeting of representative machine screw manufacturers and individuals connected therewith, held in New York, April 11, 1904, certain diameters, pitches and limits for standard machine screws were adopted. Since that date it has been found advisable to modify the list of machine screw sizes which were agreed on at that time before final action was taken by the society; Mr. George M. Bond of the committee reported that the matter was still under discussion and that a final report could not be made until the spring meeting, 1907. See MACHINERY, June, 1906, for an abstract of the proposed machine screw standards.

The Evolution of Gas Power, by Mr. F. E. Junge.

The author points out the remarkable development of the gas engine within the memory of the past generation and shows that it has become a factor of consequence in the world's total energy output. In Germany alone at the present time there is a total of about 400 gas engines with a combined capacity of about 420,000 horsepower. He states that the variety of earlier forms of large gas engines has now been

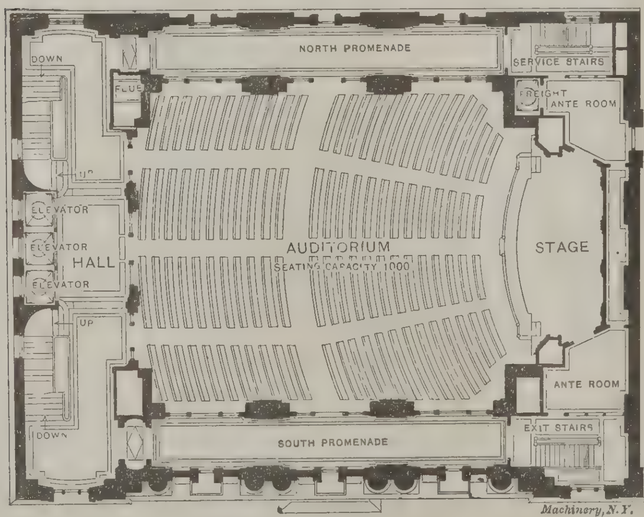


Fig. 4. Plan of Auditorium.

reduced to two classes, these being the double-acting tandem four-cycle and the double-acting two-cycle types. The single-acting type of each is only applicable in the smaller sizes. The peculiar process of charging with an open exhaust limits the two-cycle engine to speeds of from 80 to 100 as a maximum, and therefore puts this type at a disadvantage where the maximum power output is required for a given weight and space.

Producer Gas Power Plants, by Mr. J. R. Bibbins.

This timely paper on the simple producer plant calls renewed attention to its value. The author endeavors to show that the gas power plant using producer gas is a thoroughly practical form of motor power equipment; that it is reliable in operation; is suited to fluctuating loads; is comparatively simple to operate; and is more economical in point of fuel efficiency than the average steam plant of the same size and capacity.

Tests of High Duty Air Compressors, by Prof. O. P. Hood.

In the copper country of Michigan several compressed air plants exceed 1,000 horsepower each and there is one of about 5,000 horsepower. This paper reports the result of tests of a high-duty air compressor installed at the Champion copper

Prof. Frederick R. Hutton, Newly-elected President of the A. S. M. E.*

mine at Painesdale, Mich. The machine, built by the Nordberg Mfg. Co., Milwaukee, Wis., consists of four horizontal engines placed side by side and connected to a crankshaft carrying three flywheels. The engine was designed to use steam at 300 pounds pressure and was guaranteed to develop 180,000,000 foot-pounds for each million heat units used and to compress 9,000 cubic feet per minute to a pressure of 80 pounds gage at 76 revolutions per minute. The report of the tests is given in detail. It was found that owing to boiler leakage the calculated pressure of 300 pounds could not be carried and it was necessary to use the reduced pressure of 250 pounds. It was under these conditions that the contract was carried out and the tests made. The standard efficiency tests were, heat consumed by engine per I.H.P., 10,157 B.T.U.; heat consumed per hour per B.H.P., 11,382 B.T.U.; equivalent coal consumption per I.H.P., 1.016 pound; the same per B.H.P., 1.138 pound. The duty developed per million heat units supplied to the engine was 194,930,000 foot-pounds. This engine establishes a new low record for heat consumed per hour per I.H.P., being 9 per cent lower than that used by the Wildwood pumping engine reported in 1900.

Boiler and Setting, by Mr. A. Bement.

The objects proposed in this design of boiler setting are the attainment of a perfect and smokeless combustion, and the full utilization of boiler heating surfaces. The setting is applied to a water-tube boiler of the Heine type, equipped with chain grate stokers. The setting is so constructed that the gases from the firebox traverse backward to the rear of the boiler, passing under a furnace roof of peculiar construction, upward through the water tubes, then downward, repeating this circuitous path around the baffle plates until all the gases

* Frederick Remsen Hutton was born in New York City, 1853. He graduated from Columbia College in 1876; later he was made instructor in mechanical engineering and in 1892 succeeded to the chair of engineering of that institution. The American Society of Mechanical Engineers was organized in 1880 and in 1883 Prof. Hutton was made secretary, which position he has held up to the assumption of the presidency of the society at the conclusion of the December meeting. During his incumbency as secretary of the society it has grown enormously in membership and prestige. A magnificent society building of which the American Society of Mechanical Engineers is one-third owner has been constructed. Prof. Hutton is the author of a number of technical books, including Heat and Heat Engines; Gas Engines; Mechanical Engineering of Power Plants, etc. Notwithstanding his manifold duties as head of the mechanical department of Columbia University and secretary of the society, he has been active in other work connected with his profession.

have passed around the water tubes five times, when they escape past the boiler into the stack. The results are gratifying in point of smokelessness and efficiency of fuel consumption. The principal feature is the refractory tile roof construction employed for making the gases traverse to the rear of the furnace under the water tube, before coming in contact with cooling surfaces. In short the design of the furnace is such as to secure perfect combustion first; then the utmost utilization of the heat produced.

Steam Plant of the White Motor Car, by Prof. R. C. Carpenter.

This paper describes in detail the remarkable superheated steam boiler and compound engine plant with which the White automobile is equipped. The boiler is of the continuous flow or single-tube type, or what is sometimes called the "flash" type. The engine is compound with piston valves. It exhausts into an air condenser. The dimensions of the engine tested were 3 and 6 inches diameter by 4½ inches stroke, with a rating of 30 horsepower. Its weight complete was 328 pounds and the total weight of the boiler is 275 pounds, making the total weight of the combined engine and boiler 603 pounds. The pressure averaged 303 pounds per square inch and the steam was superheated, the temperature at the steam chest averaged 757 degrees F. The results were remarkable. The best showing was an average of 12.7 pounds of steam consumption per developed horsepower per hour.

Ventilation of the Boston Subway, by Mr. H. A. Carson.

The Boston Subway system is about 3½ miles long and the general scheme of ventilation is that the fresh air shall be drawn in at the stations or portals and the vitiated air shall be discharged at points midway between the passenger stations. The paper is illustrated with photographs and drawings showing how the ventilation scheme was worked out.

Flow of Liquids in Venturi Tubes, by Mr. E. P. Coleman.

This paper is an investigation of the properties of the Venturi tube and its object was to prove or disprove the accuracy of the Venturi tube as a meter for gas and vapors at comparatively low throat velocities. The Pitot tube was used as the instrument for comparison on account of its proven accuracy and its simplicity. The result of the experiment is an apparent close agreement of the theoretical flow of air through a Venturi meter and the flow as derived from a Pitot tube observation.

Tests of an Elevator Plant, by Mr. A. J. Herschmann.

This paper is an account of the tests made on the plunger type elevators forming the equipment of the elevator plant of the Trinity Building, New York City, while in regular operation. Two series of tests are tabulated. In the first a duplex compound pump was used; and in the second, a flywheel pump. It was found that the cost of coal per car-mile was 5.22 cents with the flywheel pump and 8.04 cents with the duplex compound pump.

Test of a Rotary Pump, by Prof. W. B. Gregory.

This is an account of the test of a rotary pump installation consisting of four units of the cycloidal rotary pump erected on the Neches Canal Co.'s property near Beaumont, Texas. The pumps were driven by 18 x 36 x 48-inch tandem compound condensing Corliss engines direct connected. The displacement of each pump is 605 gallons per revolution. The water is elevated 32 feet. It was found that the mechanical efficiency of the two pump units average 83.3 per cent.

Improved Transmission Dynamometer, by Prof. W. F. Durand.

The paper calls attention to a modified form of Tatham dynamometer in which four sprocket wheels are used all in one plane with an automobile or bicycle chain connector instead of leather belt, thus giving a non-slip drive. The load is measured by the turning moment of the beam carrying the two idler wheels, the other two being mounted on stationary bearings.

A Plan to Provide Skilled Workmen, by Mr. M. W. Alexander.

This paper is an account of the work of the General Electric Co., at West Lynn, Mass., in training boys and young men to become practical machinists and patternmakers. The General Electric Co. have established two training rooms, one for machinists and toolmakers, with about 10,000 square feet of floor space and about 105 representative machine tools; and a smaller department for wood and metal patternmaking apprentices, with a floor space of about 1,000 square feet. The paper is coördinate with the article by Mr. Alexander which appeared in the September issue of this journal.

Saw-tooth Skylight in Factory Roof Construction, by Mr Fred S. Hinds.

The saw-tooth roof was developed to meet the needs of the textile industries. When the power cotton loom first came into use, weaving was carried on in the homes of operatives and the natural growth due to the advent of the power loom in these small establishments led to the addition of one-story structures, which, as business increased, were added to, forming what is known as a "weave shed." As these came to cover large areas it was necessary to provide roof lighting and the saw-tooth form of roof skylight was the result. Mr. Hinds' paper is illustrated with drawings showing the construction of various forms of saw-tooth roofs, and is also illustrated with photographs of the B. F. Sturtevant Co.'s plant. This plant was described and illustrated in MACHINERY, October, 1905.

Ferroinclave Construction, by Mr. A. E. Brown.

The ferroinclave roofing is a reinforced concrete structure consisting of No. 24 soft steel sheets with dovetail corrugations filled with cement mortar on both sides, so that the slab is about 1⅜ inch thick. The paper describes the structure of this roofing and gives tests of strength under various loading conditions. For an illustrated description of ferroinclave roofing see MACHINERY for October, 1903.

Saw-tooth Roofs for Factories, by Mr. K. C. Richmond.

The author defines a saw-tooth roof as a general form of skylight, a cross-section of which approximates a 30 x 60-degree draftsman's triangle with the hypothenuse horizontal, the right angle being at the top and the glass in the short leg only. These saw-teeth may be used singly, of any convenient length, and in successive rows or in any desired combination to suit any particular conditions. The object of the saw-teeth is to obtain overhead light and in most cases the windows are faced directly or nearly north. This form of roof lighting has found wide application in many kinds of factory service, including machine shops, textile mills and other plants where a large volume of diffused light is desirable. In the latitude of New York an angle of 17 degrees to 18 degrees may be employed for the glass section and still keep out the sun in the longest summer days, and this angle may be increased from 25 to 30 degrees if a small projecting cornice is built above the window. The paper is illustrated with drawings of various types of wood frame saw-teeth and is accompanied by a general discussion of the various features affecting this form of lighting. It is pointed out that in textile industries a better class of help is attracted by the good lighting afforded by the saw-tooth roof construction.

Our Present Weights and Measures and the Metric System, by Mr. Henry R. Towne.

This scholarly paper is a discussion of the present weights and measures and it advocates an improvement to the end that the system shall be uniform with that of Great Britain. The United States liquid gallon contains 231 cubic inches, while the imperial or British wine gallon contains 277.274 cubic inches. There should be an agreement between the two. Mr. Towne is opposed to the introduction of the metric system and quotes extensively to show that its introduction would mean a revolution in existing conditions which is unthinkable from a practical standpoint. He recommends the creation of a technical commission by Congress which shall study and report on the whole subject of weights and measures.

Mechanical Engineering Index, by Profs. W. W. Bird and A. L. Smith.

This paper is descriptive of the engineering index in the department of mechanical engineering of the Worcester Polytechnic Institute. The paper includes nearly 500 heads, 1,100 sub-heads, and the cross references, all amounting to fifty-six pages of the proceedings. To any one interested in the subject of intelligent and comprehensible indexing of engineering literature the paper is well worth attention.

ON THE ART OF CUTTING METALS.—1.*

FRED. W. TAYLOR.†

Fred. W. Taylor.

The experiments described in this paper were undertaken to obtain a part of the information necessary to establish in a machine shop our (Taylor) system of management, the central idea of which is:

A. To give each workman each day in advance a definite task, with detailed written instructions, and an exact time allowance for each element of the work.

B. To pay extraordinarily high wages to those who perform their tasks in the allotted time, and ordinary wages to those who take more than their time allowance.

There are three questions which must be answered each day in every machine shop by every machinist who is running a metal-cutting machine, such as a lathe, planer, drill press, milling machine, etc., namely:

a. What tool shall I use?

b. What cutting speed shall I use?

c. What feed shall I use?

Our investigations, which were started twenty-six years ago with the definite purpose of finding the true answer to these questions under all the varying conditions of machine shop practice have been carried on up to the present time with this as the main object still in view.

The writer will confine himself almost exclusively to an attempted solution of this problem as it affects "roughing work"; *i.e.*, the preparation of the forgings or casting for the final finishing cut, which is taken only in those cases where great accuracy or high finish is called for. Fine finishing cuts will not be dealt with. Our principal object will be to describe the fundamental laws and principles which will enable us to do "roughing work" in the shortest time, whether the cuts are light or heavy, whether the work is rigid or elastic, and whether the machine tools are light and of small driving power or heavy and rigid with ample driving power.

In other words, our problem is to take the work and machines as we find them in a machine shop, and by properly changing the countershaft speeds, equipping the shop with tools of the best quality and shapes, and then making a slide rule for each machine to enable an intelligent mechanic with the aid of these slide rules to tell each workman how to do each piece of work in the quickest time.

The three great questions, as to shape of tools, speed, and feed, above referred to, are daily answered for all of the men in each shop far better by our one trained mechanic with the aid of his slide rule than they were formerly by the many machinists, each one of whom ran his own machine, etc., to suit his foreman or himself. It may seem strange to say that a slide rule enables a good mechanic to double the output of a machine which has been run, for example, for ten years by a first-class machinist having exceptional knowledge of and experience with his machine, and who has been using his best judgment. Yet, our observation shows that, on the average, this understates the fact.

Twelve Variables Affect the Production of Chips.

To make the reason for this more clear it should be understood that the man with the aid of his slide rule is called upon to determine the effect which each of the twelve elements or variables given below has upon the choice of cutting speed and feed; and it will be evident that the mechanic, or expert or mathematician does not live who, without the aid of a slide rule or its equivalent, can hold in his head these twelve variables and measure their joint effect upon the problem.

These twelve elements or variables are as follows:

a. The quality of the metal which is to be cut;
b. The diameter of the work;
c. The depth of the cut;
d. The thickness of the shaving;
e. The elasticity of the work and of the tool;
f. The shape or contour of the cutting edge of the tool, together with its clearance and lip angles;
g. The chemical composition of the steel from which the tool is made, and the heat treatment of the tool;
h. Whether a copious stream of water, or other cooling medium, is used on the tool;
j. The duration of the cut, *i. e.*, the time which a tool must last under pressure of the shaving without being reground;
k. The pressure of the chip or shaving upon the tool;
l. The changes of speed and feed possible in the lathe;
m. The pulling and feeding power of the lathe.

Broadly speaking, the problem of studying the effect of each of the above variables upon the cutting speed and of making this study practically useful, may be divided into four sections as follows:

A. The determination by a series of experiments of the important facts or laws connected with the art of cutting metals.

B. The finding of mathematical expressions for these laws which are so simple as to be suited to daily use.

C. The investigation of the limitations and possibilities of metal cutting machines.

D. The development of an instrument (a slide rule) which embodies, on the one hand, the laws of cutting metals, and on the other, the possibilities and limitations of the particular lathe or planer, etc., to which it applies and which can be used by a machinist without mathematical training to quickly indicate in each case the speed and feed which will do the work quickest and best.

How the Investigation was Started and how it has been Carried Along.

In the fall of 1880, the machinists in the small machine shop of the Midvale Steel Company, Philadelphia, most of whom were working on piecework in machining locomotive tires, car axles, and miscellaneous forgings, had combined to do only a certain number of pieces per day on each type of work. The writer, who was the newly appointed foreman of the shop, realized that it was possible for the men to do in all cases much more work per day than they were accomplishing. He found, however, that his efforts to get the men to increase their output were blocked by the fact that his knowledge of just what combination of depth of cut, feed and cutting speed would in each case do the work in the shortest time, was much less accurate than that of the machinists who were combined against him. His conviction that the men were not doing half as much as they should do, however, was so strong that he obtained the permission of the management to make a series of experiments to investigate the laws of cutting metals with a view to obtaining a knowledge at least equal to that of the combined machinists who were under him. He expected that these experiments would last not longer than six months. With the exception of a few comparatively short periods, however, these experiments have continued *until the present time*, through a term of about 26 years.

The writer wishes to call attention to the fact that in these first experiments he was far more fortunate than almost all of the experimenters who have investigated the subject since then, in having at his disposal a comparatively large mass of uniform metal to work upon, and a comparatively large and powerful machine to work with, a 66-inch diameter boring mill and large locomotive tires made of hard tire steel of uniform quality having been used. He was also especially fortunate in having over him as president of the company, Mr. William Sellers, who, as is well known, was one of the most patient and broad-minded experimenters of his day. Mr. Sellers, in spite of the protests which were made against the continuation of this work, allowed the experiments to proceed; even, at first, at a very considerable inconvenience and loss to the shop. The extent of this inconvenience will be appreciated when it is understood that we were using a 66-inch diameter vertical boring mill, belt-driven by the usual cone pulleys, and that in order to regulate the exact cutting speed of the tool, it was necessary to slow down the speed of the engine that drove all of the shafting in the shop; a special adjustable engine governor having been bought for this purpose. For over two years the whole shop was incon-

* Abstract of introduction of paper read before the December, 1906, meeting of the American Society of Mechanical Engineers.
† For biographical sketch, see MACHINERY, January, 1906.

venienced in this way, by having the speed of its main line of shafting greatly varied, not only from day to day but from hour to hour. Before the two years had elapsed, however, the writer had obtained such valuable and unexpected results from the experiments as to much more than justify all of the annoyance and expenditure, and soon after that he readily obtained permission to employ a young technical graduate to devote his whole time to the continuation of this work.

Mr. G. M. Sinclair, a graduate of Stevens Institute of Technology, devoted his entire time to this work from 1884 to 1887, when he left the employ of the company.

Mr. H. L. Gantt, also a graduate of Stevens Institute succeeded Mr. Sinclair in July, 1887, and has been interested with us in carrying on these experiments throughout their whole period.

In 1898 Mr. Maunsel White, of Bethlehem, another graduate of Stevens Institute, joined us and has been actively interested in our work up to this time.

Mr. Carl G. Barth, a graduate of the Technical School of Horten, Norway, joined us in 1899, and is still actively working on our investigations.

Our experiments were continued in the works of the Midvale Steel Company until 1889, when the writer left their employ. Since then, these investigations have been carried on in various shops and at the expense of different companies. Among these, we would especially acknowledge our indebtedness to the Cramp's Shipbuilding Company, Messrs. Wm. Sellers & Co., the Link-Belt Engineering Company, Messrs. Dodge & Day, and, more than all, to the Bethlehem Steel Company.

In carrying on this work more than ten machines have been fitted up at various times with special driving apparatus and the other needed appliances, all machines used since 1894 having been equipped with electric drives, so as to obtain any desired cutting speed. The thoroughness with which the work has been done may perhaps be better appreciated when it is understood that we have made between thirty and fifty thousand recorded experiments, and many others of which no record was kept. In studying these laws we have cut up into chips with our experimental tools more than 800,000 pounds of steel and iron. More than sixteen thousand experiments were recorded in the Bethlehem Steel Company. We estimate that up to date between $150,000 and $200,000 have been spent upon this work, and it is a very great satisfaction to feel that those whose generosity has enabled us to carry on the experiments have received ample return for their money through the increased output and the economy in running their shops which have resulted from our experiments.

Throughout the whole 26 years we have succeeded in keeping almost all of these laws secret, and in fact since 1889 this has been our means of obtaining the money needed to carry on the work. We have never sold any information connected with this art for cash, but we have given to one company after another all of the data and conclusions arrived at through our experiments in consideration for the opportunity of still further continuing our work.

Summary of Discoveries.

The writer has no doubt that many of the discoveries and conclusions which mark the progress of this work have been and are well known to other engineers, and we do not record them with any certainty that we were the first to discover or formulate them, but merely to indicate some of the landmarks in the development of our own experiments, which to us were new and of value. The following is a record of some of our more important steps:

A. In 1881, the discovery that a round-nosed tool could be run under given conditions at a much higher cutting speed and therefore turn out much more work than the old-fashioned diamond-pointed tool.

B. In 1881, the demonstration that, broadly speaking, the use of coarse feeds accompanied by their necessarily slow cutting speeds would do more work than fine feeds with their accompanying high speeds.

C. In 1883, the discovery that a heavy stream of water poured directly upon the chip at the point where it is being removed from the steel forging by the tool, would permit an increase in cutting speed, and, therefore, in the amount of work done of from 30 to 40 per cent. In 1884, a new machine shop was built for the Midvale Steel Works, in the construction of which this discovery played a most important part; each machine being set in a wrought-iron pan in which was collected the water (supersaturated with carbonate of soda to prevent rusting), which was thrown in a heavy stream upon the tool for the purpose of cooling it. The water from each of these pans was carried through suitable drain pipes beneath the floor to a central well from which it was pumped to an overhead tank from which a system of supply pipes led to each machine. Up to that time, so far as the writer knows, the use of water for cooling tools was confined to small cans or tanks from which only a minute stream was allowed to trickle upon the tool and the work, more for the purpose of obtaining a water finish on the work than with the object of cooling the tool; and, in fact, these small streams of water are utterly inadequate for the latter purpose. So far as the writer knows, in spite of the fact that the shops of the Midvale Steel Works until recently have been open to the public since 1884 no other shop in this country was similarly fitted up until that of the Bethlehem Steel Company in 1899, with the one exception of a small steel works which was an offshoot in personnel from the Midvale Steel Company.

D. In 1883, the completion of a set of experiments with round-nosed tools; first, with varying thicknesses of feed when the depth of the cut was maintained constant; and, second, with varying depths of cut while the feed remained constant, to determine the effect of these two elements on the cutting speed.

E. In 1883, the demonstration of the fact that the longer a tool is called upon to work continuously under pressure of a shaving, the slower must be the cutting speed, and the exact determination of the effect of the duration of the cut upon the cutting speed.

F. In 1883, the development of formulas which gave mathematical expression to the two broad laws above referred to. Fortunately these formulas were of the type capable of logarithmic expression and therefore suited to the gradual mathematical development extending through a long period of years, which resulted in making our slide rules, and solved the whole problem in 1901.

G. In 1883, the experimental determination of the pressure upon the tool required on steel tires to remove cuts on varying depths and thickness of shaving.

H. In 1883, the starting of a set of experiments on belting described in a paper published in the Transactions, A. S. M. E., Vol. 15 (1894).

J. In 1883, the measurement of the power required to feed a round-nosed tool with varying depths of cut and thickness of shaving when cutting a steel tire. This experiment showed that a *very dull tool* required as much pressure to feed it as to drive the cut. This was one of the most important discoveries made by us, and as a result all steel cutting machines purchased since that time by the Midvale Steel Company have been supplied with feeding power equal to their driving power and very greatly in excess of that used on standard machine tools.

K. In 1884, the design of an automatic grinder for grinding tools in lots and the construction of a tool room for storing and issuing tools ready ground to the men.

L. From 1885 to 1889, the making of a series of practical tables for a number of machines in the shops of the Midvale Steel Company, by the aid of which it was possible to give definite tasks each day to the machinists who were running machines, and which resulted in a great increase in their output.

M. In 1886, the demonstration that the thickness of the chip or layer of metal removed by the tool has a much greater effect upon the cutting speed than any other element, and the practical use of this knowledge in making and putting into everyday use in our shops a series of broad-nosed cutting tools which enabled us to run with a coarse feed at as high a speed as had been before attained with round-nosed tools when using a fine feed, thus sustituting, for a considerable portion of the work, *coarse feeds and high speeds* for our old maxim of *coarse feeds and slow speeds.*

N. In 1894 and 1895, the discovery that a greater proportional gain could be made in cutting soft metals through the use of tools made from self-hardening steels than in cutting hard metals, the gain made by the use of self-hardening tools over tempered tools in cutting soft cast-iron being almost 90 per cent, whereas the gain in cutting hard steels or hard cast iron was only about 45 per cent. Up to this time, the use of Mushet and other self-hardening tools had been almost exclusively confined to cutting hard metals, a few tools made of Mushet steel being kept on hand in every shop for special use on hard castings or forgings which could not be cut by the tempered tools. This experiment resulted in substituting self-hardening tools for tempered tools for all "roughing work" throughout the machine shop.

P. In 1894 and 1895, the discovery that in cutting wrought iron or steel a heavy stream of water thrown upon the shaving at the nose of the tool produced a gain in cutting speed of *self-hardening tools* of about 33 per cent. Up to this time the

makers of self-hardening steel had warned users never to use water on the tools.

Q. From 1898 to 1900, the discovery and development of the Taylor-White process of treating tools; namely, the discovery that tools made from chromium-tungsten steels when heated to the melting point would do from two to four times as much work as other tools.

R. In 1899-1902, the development of our slide rules, which are so simple that they enable an ordinary workman to make practical and rapid everyday use in the shop of all the laws and formulas deduced from our experiments.

S. In 1906, the discovery that a heavy stream of water poured directly upon the chip at the point where it is being removed from *cast iron* by the tool would permit an increase in cutting speed, and therefore, in the amount of work done, of 16 per cent.

T. In 1906, the discovery that by adding a small quantity of vanadium to tool steel to be used for making modern high speed chromium-tungsten tools heated to near the melting point, the hardness and endurance of tools, as well as their cutting speeds, are materially improved.

Chief Practical Value of Discoveries Embodied in the Slide Rule.

While many of the results of these experiments are both interesting and valuable, we regard as of by far the greatest value that portion of our experiments and of our mathematical work which has resulted in the development of the slide rules; *i. e.*, the patient investigation and mathematical expression of the exact effect upon the cutting speed of such elements as the shape of the cutting edge of the tool, the thickness of the shaving, the depth of the cut, the quality of the metal being cut and the duration of the cut, etc. This work enables us to fix a daily task with a definite time allowance for each workman who is running a machine tool, and to pay the men a bonus for rapid work.

The gain from these slide rules is far greater than that of all the other improvements combined, because it accomplishes the original object, for which in 1880 the experiments were started; *i. e.*, that of taking the control of the machine shop out of the hands of the many workmen, and placing it completely in the hands of the management, thus superseding "rule of thumb" by scientific control.

Mistakes of Not Originally Determining Each Variable Separately—Standard of Twenty Minutes for Each Test.

Almost the whole course of our experiments is marked by imperfections in our methods, which, as we have realized them, have led us to go again more carefully over the ground previously traveled. These errors may be divided into three principal classes:

A. The adoption of wrong or inadequate standards for measuring the effect of each of the variables upon the cutting speed.

B. Failure on our part from various causes to hold all of the variables constant except the one which was being systematically changed in order to study the effect of these changes upon the cutting speed.

C. The omission either through oversight or carelessness on our part of some one of the precautions which should be taken to insure accuracy, or failure to record some of the phenomena considered unimportant at the time, but which afterward proved to be essential to a complete understanding of the facts.

The effect of each variable upon the problem is best determined by finding the exact rate of cutting speed (say, in feet per minute) which shall cause the tool to be completely ruined after having been run for 20 minutes under uniform conditions. For example, if we wish to investigate the effect which a change in the thickness of the feed has upon the cutting speed, it is necessary to make a number of tools which are in all respects uniform, as to the exact shape of their cutting edge, their clearance and lip angles, their chemical composition and their heat treatment. These tools must then be run one after another, each for a period of 20 minutes, throughout which time the cutting speed is maintained exactly uniform. Each tool should be run at a little faster cutting speed than its predecessor, until that cutting speed has been found which will cause the tool to be completely ruined at the end of 20 minutes (with an allowance of a minute or two each side of the 20-minute mark). In this way that cutting speed is found which corresponds to the particular thickness of shaving which is under investigation.

A change is then made in the thickness of the shaving, and another set of 20-minute runs is made, with a series of similar uniform tools, until the cutting speed corresponding to the new thickness of feed has been determined; and by continuing in this way all of the cutting speeds are found which correspond to the various changes of feed. In the meantime, every precaution must be taken to maintain uniform all the other elements or variables which affect the cutting speed, such as the depth of the cut and the quality of the metal being cut; and the rate of the cutting speed must be frequently tested during each 20-minute run to be sure that it is uniform.

The cutting speeds corresponding to varying feeds are then plotted as points upon a curve, and a mathematical expression is found which represents the law of the effect of feed upon cutting speed. We believe that this standard or method of procedure constitutes the very foundation of successful investigation in this art. It was only after about 14 years' work that we found that the best measure for the value of a tool lay in the exact cutting speed at which it was completely ruined at the end of 20 minutes.

Pressure and Rubbing of Chip what Breaks Down Tool.

The ultimate cause for a tool giving out when cutting metal is the dullness or wear of the tool produced by the rubbing or pressure of the chip upon the lip surface of the tool, and the chief element causing this wear, particularly at the high speeds at which tools should be run to do their best work, is the softening of the tool due to the heat produced by the friction of the chip upon its lip surface. Now, it seems perfectly evident that this heat will be increased directly in proportion to three elements:

a. The pounds of pressure of the chip upon the tool;

b. The speed with which the chip slides across the nose of the tool;

c. The coefficient of friction between the chip and the surface of the tool.

And yet, paradoxical as it may seem, the writer asserts that *there is no traceable relation between the pressure of the chip upon the tool and the cutting speed.*

Discovery of Taylor-White Process.

It is a noteworthy fact that when thorough investigations are attempted by earnest men in new fields, while frequently the object aimed at is not attained, yet quite often discoveries are made which are entirely foreign to the purpose for which the investigation was undertaken. And it may be said that the indirect results of careful scientific work are, generally speaking, fully as valuable as the direct. Two interesting illustrations of this fact have been furnished by our experiments.

The discovery of the Taylor-White process of treating tools by heating them almost to the melting point, or, in other words, the introduction of modern high speed tools the world over, was the indirect result of one of our lines of investigation.

The demonstration of the fact that the rules for using belting in common practice furnished belts which were entirely too light for economy was also one of the indirect results of our experiments.

The manner of making these discoveries was each time in a way so typical of what may be expected in similar cases that it would seem worth while to describe it in some detail.

During the winter of 1894-1895, the writer conducted an investigation in the shop of Wm. Sellers & Co., at the joint expense of Messrs. William Cramp & Sons, shipbuilders, and Messrs. Wm. Sellers & Co., to determine which make of self-hardening tool steel was, on the whole, the best to adopt as standard for all of the roughing tools of these two shops.

As a result of this work, the choice was narrowed down at that time to two makes of tool steel: (1) the celebrated Mushet self-hardening steel, the chemical composition of the particular bar analyzed at this time being as follows:

Tungsten, (per cent) 5.441; chromium, 0.398; carbon, 2.150; manganese, 1.578; silicon, 1.044.

(2) A self-hardening steel made by the Midvale Steel Company of the following chemical composition:

Tungsten, (per cent) 7.723; chromium, 1.830; carbon, 1.143; manganese, 0.180; silicon, 0.246; phosphorus, 0.023; sulphur, 0.008.

Of these two steels, the tools made from the Midvale steel were shown to be capable of running at rather higher cutting

speeds. The writer himself heated hundreds of tools of these makes in the course of his experiments in order to accurately determine the best temperatures for forging and heating them prior to grinding so as to get the best cutting speeds. In these experiments he found that the Mushet steel if overheated crumbled badly when struck even a light blow on the anvil, while the Midvale steel if overheated showed no tendency to crumble, but, on the other hand, was apparently permanently injured. In fact, heating these tools slightly beyond a bright cherry red caused them to permanently fall down in their cutting speeds; and the writer was unable at that time to find any subsequent heat treatment which would restore a tool broken down in this way to its original good condition. This defect in the Midvale tools left us in doubt as to whether the Mushet or the Midvale was, on the whole, the better to adopt as a shop standard.

In the summer of 1898, soon after undertaking the reorganization of the management of the Bethlehem Steel Company, the writer decided to continue the experiments just referred to with a view to ascertaining whether in the meanwhile some better tool steel had not been developed. After testing several additional makes of tools, our experiments indicated that the Midvale self-hardening tools could be run if properly heated at slightly higher speeds than those of any other make.

Upon deciding to adopt this steel as our standard the writer had a number of tools of each make of steel carefully dressed and ground to exactly the same shape. He then called the foremen and superintendents of the machine shops of the Bethlehem Steel Company to the experimental lathe so that they could be convinced by seeing an actual trial of all of the tools that the Midvale steel was, on the whole, the best. In this test, however, the Midvale tools proved to be worse than those of any other make; *i. e.*, they ran at slower cutting speeds. This result was rather humiliating to us as experimenters who had spent several weeks in the investigation.

It was of course the first impression of the writer that these tools had been overheated in the smith shop. Upon careful inquiry among the smiths, however, it seemed as though they had taken special pains to dress them at a low heat, although the matter was left in much doubt. The writer, therefore, determined to make a thorough investigation before finally adopting the Midvale steel as our shop standard to discover, if possible, some heat treatment which would restore Midvale tools injured in their heating (whether they had been underheated or overheated) to their original good condition.

For this purpose Mr. White and the writer started a carefully laid out series of experiments, in which tools were to be heated at temperatures increasing, say, by about 50 degrees all the way from a black heat to the melting point. These tools were then to be ground and run in the experimental lathe upon a uniform forging, so as to find:

a. That heat at which the highest cutting speed could be attained (which our previous experiments had shown to be a cherry red).

b. To accurately determine the exact danger point at which if over or underheated these tools were seriously injured.

c. To find some heat treatment by which injured tools could be restored to their former high cutting speeds.

These experiments corroborated our Cramp-Sellers experiments, showing that the tools were seriously broken down or injured by overheating, say, somewhere between 1,550 degrees F. and 1,700 degrees F.; but to our great surprise, tools heated up to or above the high heat of 1,725 degrees F. proved better than any of those heated to the best previous temperature, namely, a bright cherry red; and from 1,725 degrees F. up to the incipient point of fusion of the tools, the higher they were heated, the higher the cutting speeds at which they would run.

Thus, the discovery that phenomenal results could be obtained by heating tools close to the melting point, which was so completely revolutionary and directly the opposite of all previous heat treatment of tools, was the indirect result of an accurate scientific effort to investigate as to which brand of tool steel was, on the whole, the best to adopt as a shop standard; neither Mr. White nor the writer having the slightest idea that overheating beyond the bright cherry red would do anything except injure the tool more and more the higher it was heated.

Ordinary Belting Too Light.

During our early Midvale Steel Company experiments, extending from 1880 to 1883, the writer had so much trouble in maintaining the tension of the belt used in driving the boring mill upon which he was experimenting that he concluded: (1) that belting rules in common use furnished belts entirely too light for economy; and (2) that the proper way to take care of belting was to have each belt in a shop tightened at regular intervals with belt clamps especially fitted with spring balances, with which the tension of the belt was accurately weighed every time it was tightened, each belt being retightened each time to exactly the same tension.

In 1884, the writer designed and superintended the erection of a new machine shop for the Midvale Steel Company, and this gave him the opportunity to put these conclusions to a practical test. About half the belts in the shop were designed according to the ordinary rules and the other half were made about three times as heavy as the usual standard. This shop ran day and night. The belts were in all cases cared for and retightened only upon written orders sent from the shop office; and an accurate record was kept through nine years of all items of interest concerning each belt, namely: the number of hours lost through interruption to manufacture; the number of times each belt interrupted manufacture; the original cost of each belt; the detail costs of tightening, cleaning and repairing each belt; the fall in the tension before requiring retightening; and the time each belt would run without being retightened. Thus at the end of nine years these belts furnished a record which demonstrated beyond question many important facts connected with the use of belting, the principal of these being that the ordinary rules gave belts only about one-half as heavy as should be used for economy. This belting experiment illustrates again the good that often comes indirectly from experiments undertaken in an entirely different field.

Need of Standardization.

Too much emphasis cannot be laid upon the fact that standardization really means simplification. It is far simpler to have in a standardized shop two makes of tool steel than to have 20 makes of tool steel, as will be found in shops under the old style of management. It is far simpler to have all of the tools in a standardized shop ground by one man to a few simple but rigidly maintained shapes than to have, as is usual in the old-style shop, each machinist spend a portion of each day at the grindstone, grinding his tools with radically wrong curves and cutting angles, merely because bad shapes are easier to grind than good. Hundreds of similar illustrations could be given showing the true simplicity (not complication) which accompanies the new type of management.

No one doubts for one minute that it is far simpler to run a shop with a boiler, steam engine, shafting, pulleys and belts than it would be to run the same shop with the old-fashioned foot power, yet the boiler, steam engine, shafting, pulleys and belts require, as supernumeraries or non-producers on the payroll, a fireman, an engineer, an oiler, and often a man to look after belts. The old style manager, however, who judges of complication only by comparing the number of non-producers with that of the producers, would find the steam engine merely a complication in management. The same man, to be logical, would find the whole drafting force of an engineering establishment merely a complication, whereas in fact it is a great simplification over the old method.

Individual Motor Drive Not Recommended.

There is one recommendation, however, in modern machine shop practice in making which the writer will probably be accused of being old-fashioned or ultra-conservative. Of late years there has been what may be almost termed a blind rush on the part of those who have wished to increase the efficiency of their shops toward driving each individual machine with an independent motor. The writer is firmly convinced through large personal observation in many shops and through having himself systematized two electrical works that in perhaps three cases out of four a properly designed belt drive is preferable to the individual motor drive for machine tools. There is no question that through a term of years the total cost, on the one hand, of individual motors and electrical wiring, cou-

pled with the maintenance and repairs, of this system will far exceed the first cost of properly designed shafting and belting plus maintenance and repairs (in most shops entirely too light belts and countershafts of inferior design are used, and the belts are not systematically cared for by one trained man, and this involves a heavy cost for maintenance). There is no question, therefore, that in many cases the motor drive means in the end additional complication and expense rather than simplicity and economy.

* * *

FORMULAS FOR DETERMINING THE PROPORTIONS OF TAPS.

ERIK OBERG.

It has been a very common thing among manufacturers of taps, and still more among persons who only occasionally have been called upon to make these tools, to produce taps without following any definite rule as to the proportions of the various details. Little attention has been given to the possibility of expressing the relation between the diameter and the total length, for instance, by a simple formula. For this reason it is very common to find that the dimensions of taps, or of any other tools of a similar character which are made in a great number of sizes, do not follow any definite rule in their proportions, except the one that a larger size has most of its dimensions a trifle larger than those of the preceding one; even this, however, is not always the case as persons familiar with small tools cannot have helped but notice. Various manufacturers also differ widely as to the proportions of their tools. For this reason the writer has made an attempt to express the rules according to which taps of proper proportions could be made in simple formulas. These formulas are all worked out so that all the dimensions of the tap stand in a certain relation to the diameter of the tap. This insures a tap which will be well proportioned and at the same time it will be well adapted for its work, even if the pitch of the thread should vary for the same diameter. The formulas are worked out with particular regard to taps with standard threads, either United States standard or sharp V-thread, but will be equally serviceable for finer pitches.

Hand Taps.

If we first consider the case of ordinary hand taps, we will find that it is not possible to get a set of formulas which will be suitable for all sizes from the very smallest to the very largest. For this reason we must work out one set of formulas which will be adapted for sizes up to and including one inch in diameter, and one set for larger sizes. In the formulas:

A = the total length of the tap,
B = the length of the thread,
C = the length of the shank,
D = the diameter of the tap,
E = the diameter of the shank,
F = the size of the square,
G = the length of the square.

For sizes up to and including one inch in diameter our formulas are:

$A = 3.5D + 1\frac{5}{8}$ inch,
$B = 2D + \frac{1}{2}$ inch,
$C = 1.5D + 1\frac{1}{8}$ inch,
E = root diameter of thread — 0.01 inch,
$F = 0.75E$,
$G = 0.75D + 1/16$ inch.

For sizes one inch and larger our formulas will be:

$A = 2.25D + 2\frac{7}{8}$ inches,
$B = D + 1\frac{1}{2}$ inch,
$C = 1.25D + 1\frac{3}{8}$ inch,
E = root diameter of thread — 0.02 inch,
$F = 0.75E$,
$G = 0.33D + \frac{1}{2}$ inch.

The supplement contains tables for the dimensions of hand taps with standard threads based on these formulas. Of course, where no necessity for close fractional dimensions exists, the dimensions are only approximately those obtained from the formulas, and are given as practical working dimensions. As seen in the table the shanks for the 3/16 inch and the ¼ inch diameter taps are made equal to the diameter of the tap, according to the usual custom in manufacturing these taps.

Machine Screw Taps.

We will next give formulas for taps used for tapping the holes for regular machine screws, these taps being termed machine screw taps. In fact these taps are nothing but hand taps, but it has become customary to make them in a somewhat different way from ordinary hand taps. The shank on the smaller sizes is larger than the diameter of the tap itself, and on the larger sizes equal to the diameter of the tap. On the larger sizes there is a neck between the threaded portion and the shank, but on the smaller the thread runs directly into the shank part. In the formulas for machine screw taps:

A = the total length of the tap,
B = the length of the thread,
C = the length of the neck,
D = the diameter of the tap,
E = the length of the shank,
F = the diameter of the shank,
G = the size of the square,
H = the length of the square.

The following formulas will apply to all sizes of machine screw taps:

$A = 5D + 1\ 5/16$ inch,
$B = 3D + \frac{3}{8}$ inch,
$G = 0.75F$,
$H = 0.67D + \frac{1}{8}$ inch.

F, the diameter of the shank, is 0.125 inch up to and including No. 5 machine screw tap, and equal to D for larger sizes. Up to and including No. 7 machine screw tap there is no neck between the shank and the thread. For larger sizes

$C = 0.75D$.

For sizes up to and including No. 7

$E = 2D + 15/16$ inch.

For larger sizes

$E = 1.25D + 15/16$ inch.

The supplements contain a table based upon these formulas.

Tapper Taps.

For tapper taps we may also make up a set of empirical formulas. In these

A = the length of the thread,
B = the parallel part of the thread,
C = the chamfered part of the thread,
D = the diameter of the tap,
E = the diameter of the shank,
F = the diameter at the point of the thread.

The formulas for tapper taps up to and including 9-16 inch are as follows:

$A = 4.5D + 5/16$ inch,
$B = 2.75D + 3/16$ inch,
$C = 1.75D + \frac{1}{8}$ inch,
E = root diameter of thread — 0.01 inch,
F = root diameter of thread — $(0.005D + 0.005$ inch).

For sizes from ⅝ inch diameter to 2 inches inclusive the formulas are:

$A = 2D + 1\frac{3}{4}$ inch,
$B = 1.25D + 1$ inch,
$C = 0.75D + \frac{3}{4}$ inch,
E = root diameter of thread — 0.02 inch,
F = root diameter of thread — $(0.005D + 0.005$ inch).

By means of the formulas given, the dimensions for any intermediate size between those tabulated in the supplement may easily be determined. It is understood, of course, that the formulas have a great degree of flexibility, and that they are proposed only in order to facilitate the work of the toolmaker or draftsman to whom it is often left to settle upon the dimensions for these tools. The tables (see supplement) are worked out in order to save figuring in each individual case, but, as stated previously, give the approximate working dimensions, and do not give the close theoretical values figured from the formulas, excepting when essential.

* * *

The total railway mileage under contract for construction or in immediate prospect in the United States and Canada is over 25,000 miles.

THE PLANER VS. THE MILLING MACHINE.

H. P. FAIRFIELD.

It did not occur to me when presenting the photographs of a simple planer job in the September, 1906, issue that the editorial comment would bring out an opinion regarding the relative value, as a cost reducer, of planing and milling. The remarks as I read them, are of a general nature, and were meant to apply to grouped or strung work as it is usually done on the planer, and the particular piece shown was merely used to give point to the words.

The question of planing *versus* milling is to me an interesting one, and Mr. Edgar's presentation of his views in the November issue has interested me to the extent of showing a few more photographs, illustrating the manner in which work is being done by several of our New England firms of high standing, who have given time and thought to the subject of costs in the shop.

It may be well to mention that the object of the original illustrations was to show a simple job of planer work and the way in which it could be systematically done in a planer where only the regular equipment of the machine was available, that is to say, the usual stops, straps, bolts, leveling strips, backing strips and chucks. The piece shown is regularly done in our shops, using special fixtures, but as these might vary in different shops they were not pertinent to the purposes which were sought in the original paper.

Fig. 1 of the present paper illustrates the fixture we use

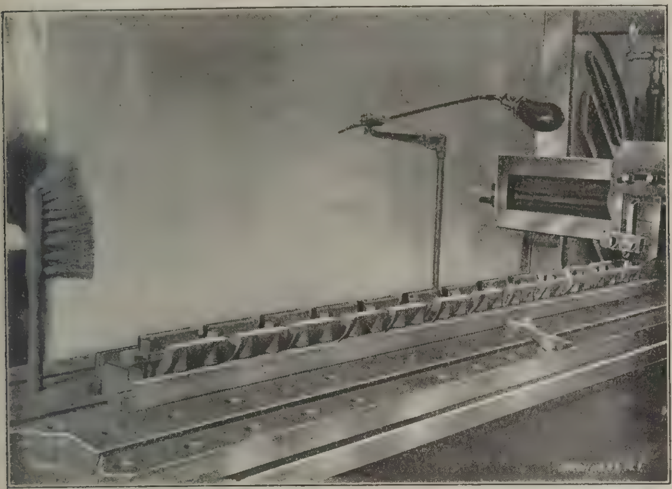


Fig. 1. Fixture for Holding Caps for Bearings while Planing.

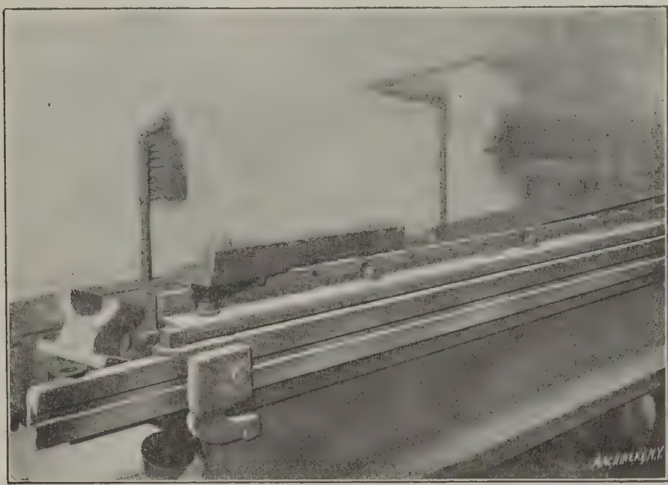


Fig. 2. Fixture for Holding Base of Bearings while Planing.

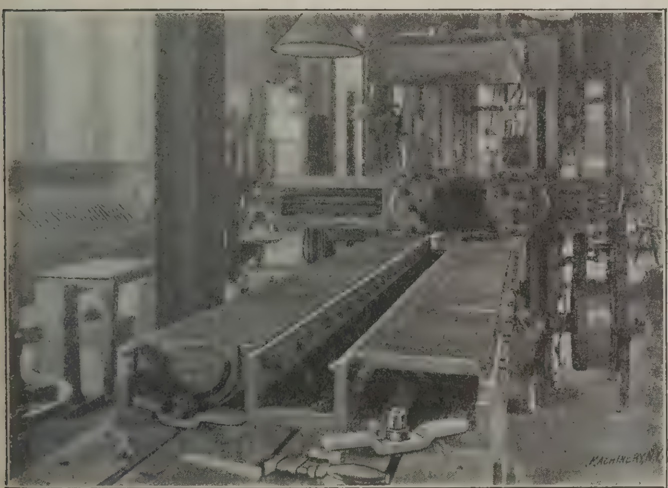


Fig. 3. Fixture for Planing Castings shown in Fig. 4.

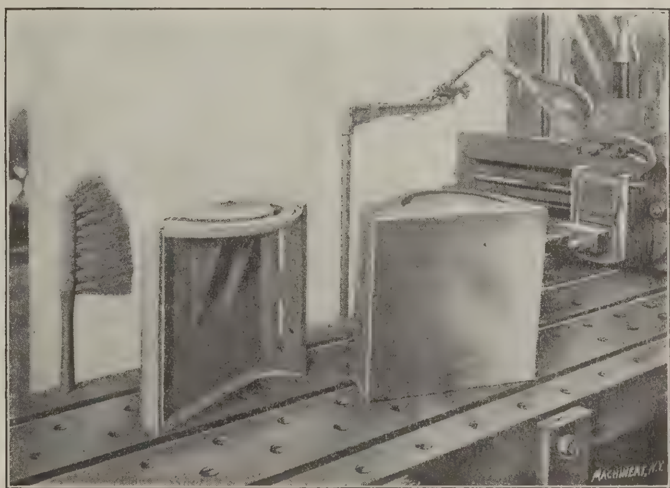


Fig. 4. Castings Planed in Manner shown in Fig. 3.

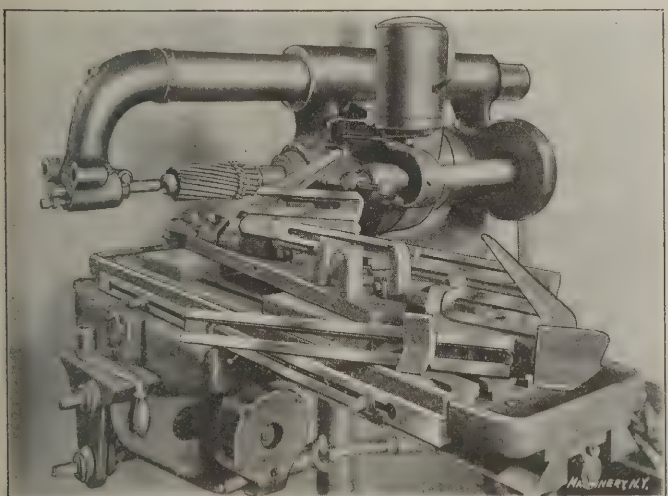


Fig. 5. Work on which the Milling Machine is Superior to the Planer.

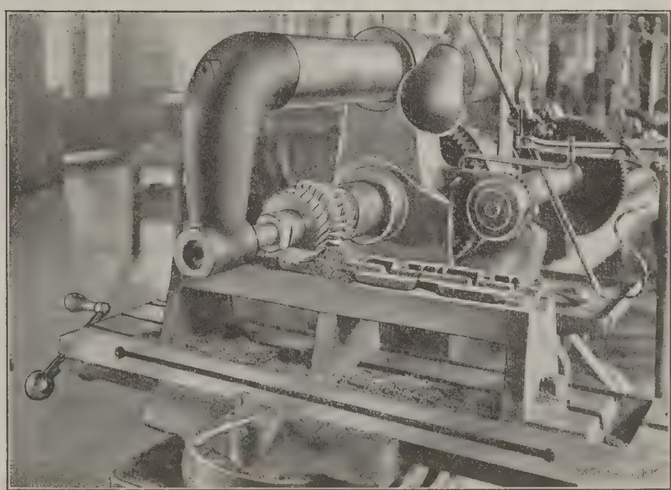


Fig. 6. Using Gang of Cutters for Rapid Finishing by Milling.

for holding the caps, and it appears to me as being much simpler than the one Mr. Edgar suggests as there are no pins or setscrews, a simple casting fitted to the planer bed comprising all there is to it.

Fig. 2 shows the fixtures used in holding the base portion of the bracket, and they will be seen to consist of a simple backing strip, undercut at the lower edge to lock the edge of the casting, and a similar strip for the front side of the

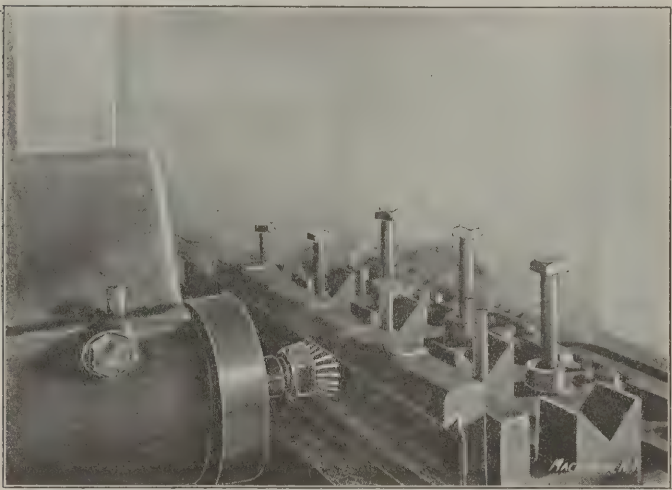


Fig. 7. Finishing Slides by Angular Cutter on the Milling Machine.

planer, fitted with setscrews at an angle suitable for forcing the casting to be held against the backing strip and down firmly to the planer platen. For ease of handling, these strips are made in short sections, but when in use they form a continuous fixture and can be used in sets, if there is more than one head mounted upon the cross-rail. This fixture, while similar to the one shown by Mr. Edgar is to my mind simpler, as no setscrews are used, or needed, in the backing. His jig or fixture for holding the piece when milling with a face cutter *might* hold the work when a light cut was being taken, but could hardly be said to be a good device as it appears trappy and locates by the wrong surfaces to insure steadiness.

Fig. 3 shows a set of fixtures designed to hold the casting shown in Fig. 4 while it is being planed. As the planer used for this work has two heads upon the cross-rail the castings are strung in two groups covering practically the whole surface of the platen.

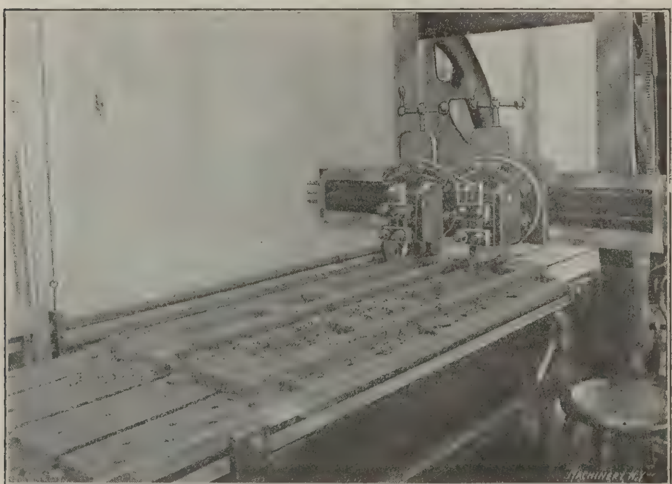


Fig. 8. A Case where Accuracy is Easier Procured by using the Planer.

A decision as to whether a piece of work shall be done upon a milling machine or in a planer often depends upon the available machine, but in our shop much experimenting has been and is being done in an honest attempt to learn which method will give the lowest piece cost. The mere question of removing stock is only a portion of the problem; the relative expense of equipment enters to some extent, but the main question in determining the method of machining is that condition of the work when leaving the different machines which calls for the least hand work to insure both accuracy and finish. An ability to chew cast iron does not mean much after all in machine construction unless other qualifications are present.

The result of experiment has led to milling some work that was formerly planed, but so far as our results show there is not much comparison between the two methods for the work shown, when time, accuracy, and low initial cost are considered. An attempt has also been made to add others' experiences to our stock of data, and considerable time has been spent in viewing what the other fellow has done. The results of all this lead us to conclude that for simple plane surfaces, the planer properly equipped with fixtures and tools by which to do the work is in the game to stay.

When such work as that shown in Fig. 5 has to be done in any considerable quantities, the milling machine will naturally be the method chosen. Fig. 6 shows another job that can be done upon an ordinary milling machine, and much quicker than on the planer. In Fig. 7 experiment has led to milling the angled side of the piece, but the reverse, which is a simple plane surface, is done upon a planer, stringing as many as convenient at a time. Figs. 8 and 9 are views that show ordinary practice, and when accuracy and piece cost is an item, in my opinion the *best* practice.

To sum up, then, my belief is that where the simpler plane surfaces that naturally lend themselves to grouping, are to be produced, the planer with a proper equipment is the natural machine to use, and will be found to give the lowest piece

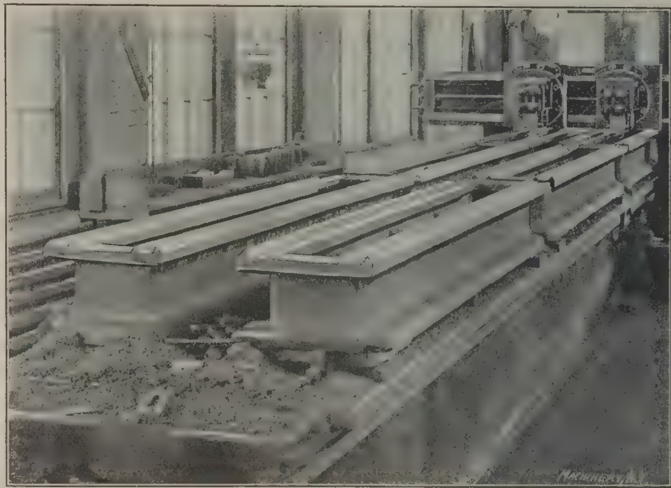


Fig. 9. Planing the Ways of Lathe Beds.

cost. It is understood, of course, that the piece cost when figured includes its proportionate share of fixed costs as it always should.

* * *

THE SIXTIETH BIRTHDAY OF BUGHOUSE BANNISTER.

THE HIRED MAN.

Bughouse Bannister was a millwright; if he had been twenty-five or thirty years old, instead of sixty, he would have been a mechanical engineer or a mechanical superintendent, or a master mechanic or a mechanical expert, but being sixty, he refused to call himself any new-fangled name.

The ambition of his life had been to bring forth a new steam engine, one that would astonish his friends, and now on his sixtieth birthday the engine was done and ready to try, and Bughouse invited his friends in to be astonished, and they certainly were astonished good and plenty! * * *

Just as firmly as Bughouse stuck to his title of millwright, he also stuck to some ideas of millwright vintage; he could not realize that mechanical art had improved to the extent that it was possible to make gears good enough so that a rack and pinion feed could be used in a machine without "the teeth showing the work," or that bevel gears could be made to run as well and be as good every way as spur gears, and so he naturally clung also to the old idea of millwright days, that one gear of a pair must have a "hunting tooth." Thus do some people refuse to be "dragged from the altars

of their forefathers," and thus was Bughouse put in a position to astonish his friends. * * * * *

It never was quite clear to me why Bughouse clung so tenaciously to the old exploded ideas, but it may be because he was over "fifty." I was told not long ago by a gentleman who is an eminent authority on *some* subjects, from which *some* people, including Bughouse, would argue that he must necessarily be also an eminent authority on *all other* subjects, that "men over fifty do not progress," but here is what is puzzling me: this eminent authority is himself "over fifty," and if he is right, men "over fifty" do *not* progress, and if they don't, *he*, being "over fifty" must be *wrong*: therefore men over fifty *do* progress, and it follows that—well, anyhow, it is evident that it is a perplexing subject, and the more you study it the more you don't find out, but all this is neither yonder nor here, as Bughouse used to call the New York & New Haven Railroad. * * * *

Bughouse started up his engine. She turned over nicely a few times, and then began to hesitate a little going by the quarter. Then instead of going by she stopped just before she got there, and came back the other way almost to the quarter, then back again, but not so near to the quarter this time, and so on, less and less, until she reversed the whole thing and started up the other way and finally made a few turns backwards.

Bughouse always said that when he made his engine he would drive the valve by gears, *because gears had more power*

"You must have a hunting tooth."

than anything else (and I have heard truly mechanical engineers say the same about gears)—so he did as he always said he would do, *and had put a "hunting tooth" in one of the gears.* * * * * * *

These peculiar motions, while they might be all right for a washing machine or a cock grinder, were no good for an engine; and this is about the way some things are "invented." A man tries to invent a peanut roaster, and when he gets it done finds it will make a much better ice cream freezer, and so calls the world to witness what a great ice cream freezer inventor he is!

I know, because I am an inventor myself.

* * * * * *

This is the first story I have ever written where the moral could not easily be seen without the aid of X-rays, but the moral of this one does not seem to be clear, probably because I am myself "over fifty," so I will need to add the only moral I can think of: *Don't have any birthdays after you are forty-nine.*"

* * *

About 35,000 American automobiles were manufactured in 1906 and it is expected that this number will be greatly exceeded in 1907, it being estimated that 45,000 cars will be manufactured to supply the enormous demand.

PERSPECTIVE VS. OBLIQUE PROJECTIONS.

FREDERIC R. HONEY.

Frederic R. Honey.

When the study of linear perspective is omitted in a course of instruction in industrial drawing, it is for the reason that it is dispensable in practical work. A knowledge of perspective is essential to the artist, however, because his work always includes the representation of objects as they appear, as distinguished from their representation in their true dimensions, which is specifically the province of the mechanical draftsman. Then, again, a knowledge of perspective is regarded as involving a considerable familiarity with complicated constructions which have no direct bearing on the work of the draftsman.

As a consequence, when it becomes necessary to represent an object pictorially, to convey to the ordinary observer a knowledge of its general form and proportions, one of the systems of oblique or of isometric projection is employed. This kind of projection is frequently introduced in drawings accompanying the specifications of patents but gives a more or less distorted view of the object.

The principle of the oblique projection is illustrated in Fig. 1. Let *abcd* represent a plane or a sheet of drawing paper. Let EF be a perpendicular line piercing the plane at F. If any oblique line be drawn from E to this plane, piercing it at e, e_1, e_2 or e_3, and this point be joined with F, any one of the lines Fe, Fe_1, Fe_2 or Fe_3 is an oblique projection of EF. The line Ee, Ee_1, Ee_2 or Ee_3 may be situated in any direction, and may form any assigned angle with the plane. That is, a perpendicular line may be represented in any direction, and may be made as long or as short as we please.

A very convenient system, and the one which the writer usually adopts, is the following: From Fig. 1 we see that all lines situated in the plane of the paper are shown in their true length and relative positions. The same is true of all lines in any plane parallel to the plane of the paper.

If we draw all lines which are perpendicular to the paper, at an angle of 45 degrees, and make them one-half of their length in space, we obtain a very simple and easily recognized representation of the object.

Let the square *abcd*, Fig. 2, represent a face of a cube in coincidence with the plane of the paper. Draw the 45-degree lines, *ae*, *bf*, *cg* and *dh*, each equal to one-half the edge of the cube, and complete the square *efgh*. The face of the cube which coincides with, and the one which is parallel to the plane of the paper, are shown in their true value.

The same will evidently be true of the cylinder, Fig. 3, as one base coincides with the paper. The 45-degree line *ab* drawn from the center *a* making *ab* equal to one-half the length of the cylinder, determines the center of the base parallel to the paper; and the figure is completed by the 45-degree lines tangent to the circles.

If we wish to represent a hollow cylinder or tube, the thickness of the material is shown in its true dimensions, and the circles described from *a* and *b* as centers complete the projection. If these figures be drawn on a large scale, the distortion would be very marked and the superiority of the perspective drawings, Figs. 4 and 5, is apparent.

Let the square *abcd*, Fig. 4, represent one face of the cube. Assume S any convenient point above the cube, and draw SD parallel to *ab*, making it equal to the distance from the eye of the observer to the paper. This measurement will fall beyond the limits of the paper as indicated by the arrow. We assume for the moment that it is accessible.

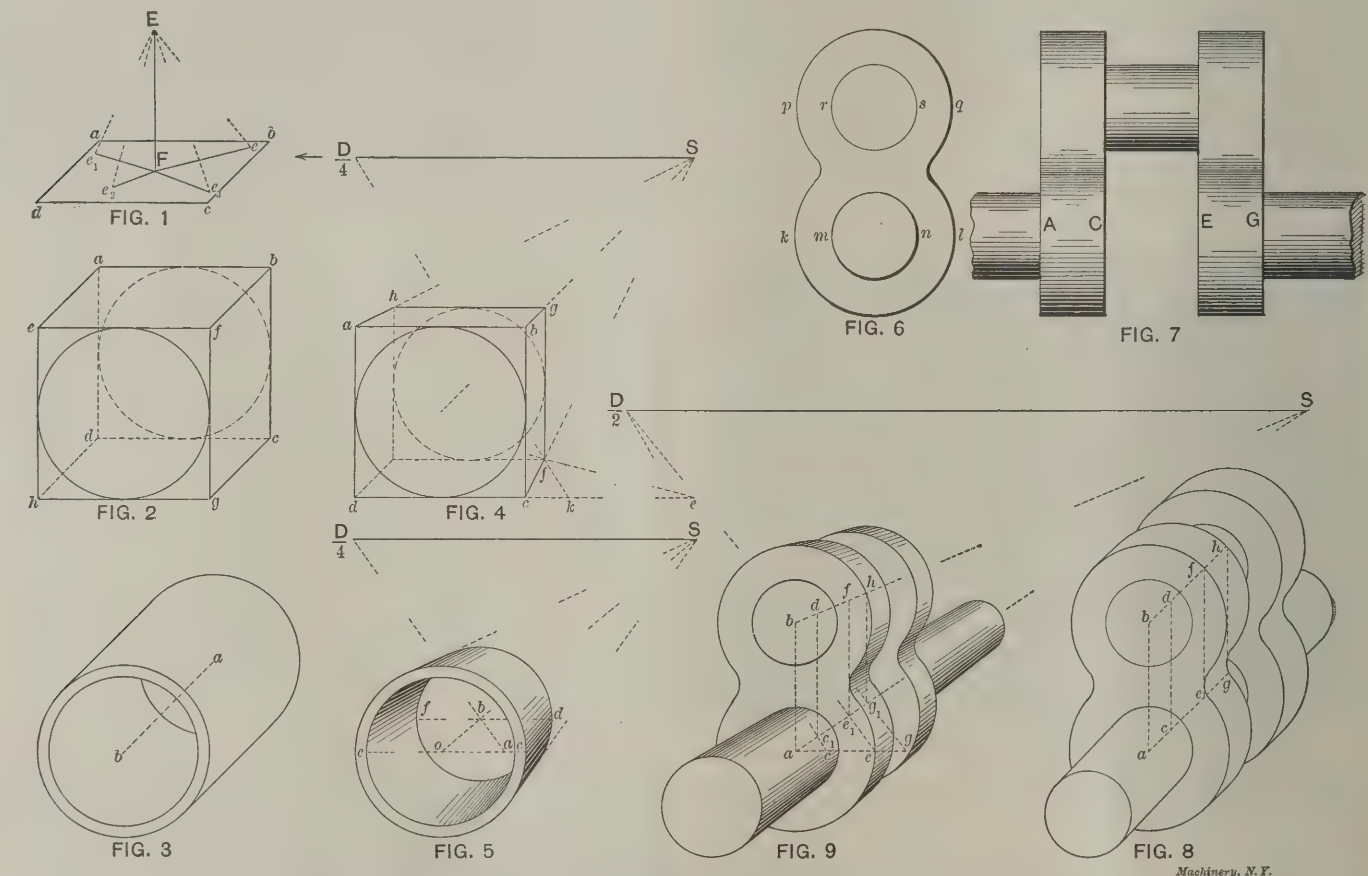
FREDERICK R. HONEY was born in London, England. He was a student at the school of Science and Art, South Kensington, London, and served an apprenticeship with Ravenhill & Co., marine engineers, London. At one time he had a position under the British Government at the Bombay Dock Yard, East Indies, and was afterward chief engineer of a steamer owned by a Parsee firm plying on the west coast of India. He is an instructor in the Sheffield Scientific School, and lecturer in the Yale School of Fine Arts and in the Art School, Smith College. Mr. Honey has been a well-known contributor to various technical publications for many years.

From a, b, c and d draw lines to S. Produce dc to e making $ce = cd$. From e draw a line to D (off the paper), intersecting cS at f. Draw the perpendicular fg and the horizontal gh, completing the perspective of the solid which is a correct perspective drawing, and which will satisfy the eye if it be placed at a distance from the paper equal to the measurement SD.

In order to bring the construction wholly within the limits of the drawing, we may mark on the line drawn from S any fractional part of the distance to D, as for example, one-fourth to $\frac{D}{4}$. If we lay off ck one-fourth of dc and draw a line from k to $\frac{D}{4}$ we obtain f, the same intersection as before. Any fraction of the distance may be laid off on SD provided the same fraction is employed on dc produced.

The height of the horizon or the level of the eye is assumed by the draftsman. S represents the point opposite the eye, or of representing an object as compared with oblique projection, we take as an example a portion of a built-up crankshaft such as is used in the most powerful reciprocating engines of our large steamships. The proportions in Figs. 6 and 7 showing two views of the crankshaft are in accordance with the best practice, and are taken from "Machine Design," by Low and Bevis. Fig. 8 is an oblique projection reduced to an assigned scale. The distance between the axes of the shaft and pin are laid off on a perpendicular from a to b. From each of these points 45-degree lines are drawn on which are laid off one-half of the measurement corresponding to those which are found in Fig. 7.

Thus $ac = bd =$ one-half of AC; $ce = df =$ one-half of CE; and $eg = fh =$ one-half of EG. From each of the centers a, c, e and g, draw two circles whose diameters are equal to kl and mn, Fig. 6. From each of the centers b, d, f and h, draw two circles whose diameters are equal to pq and rs. Connect the eye of the crankpin with that of the shaft by arcs which correspond with those of Fig. 6. The outline of Fig. 6 is repeated four times, and then 45-degree tangents showing visible lines, are drawn completing the oblique projection.



Principles and Practice of Perspective Drawing. Note the Distortion in Oblique Projections.

its projection on the paper. Its distance on the right or the left of the object is also assumed. These measurements evidently affect the apparent outline of the figure. They are selected at distances calculated to produce a satisfactory perspective drawing, *i. e.*, one which will exhibit the required details clearly. The draftsman should be careful not to make the distance from S to D too short, which would result in "steep perspective."

The application of the construction in drawing a cylinder, Fig. 5, is very simple. From o, the center of the circle, draw the horizontal line oa equal to one-fourth of the length of the cylinder.

A line drawn from a to $\frac{D}{4}$ intersects oS at b, the center of the other base. Draw bd parallel to oa. A line drawn from c to S intersects bd at d. With the radius bd draw the circle representing the other base. Tangents to the two circles drawn to S complete the outline of the figure. The drawing is completed by the circles representing the hole, the radii of which are, respectively, oe and bf.

To illustrate the use to which perspective may be put in practical work, and to indicate the superiority of this method

The perspective, Fig. 9, is drawn as follows: Draw the perpendicular ab equal to the distance between the centers of the circles, Fig. 6, and copy the end view. Assume a horizontal line $S\frac{D}{2}$ equal to one-half the distance from the eye to the paper, at any convenient distance above the figure. From a and b draw lines to S. From a draw the horizontal line ag, and lay off $ac = \frac{AC}{2}$ (Fig. 7); $ce = \frac{CE}{2}$, and $eg = \frac{EG}{2}$. From the points c, e and g draw lines to $\frac{D}{2}$, intersecting aS at c_1, e_1 and g_1. From these points draw perpendiculars intersecting bS at d, f and h. From S draw tangents to the circles representing the eyes of the pin and shaft. Perpendiculars from d, f and h drawn to one tangent; and perpendiculars from c_1, e_1 and g_1 to the other tangent, will give the radii of the remaining circles, and the draftsman will readily complete the perspective.

LETTERS UPON PRACTICAL SUBJECTS.

ANCHOR PLATES FOR FOUNDATION BOLTS.

I show herewith sketches of two styles of anchor plates. At the shop where I am employed we had been using the anchor plate shown in Fig. 1 with a square head bolt. We had to rearrange our machinery, placing much of it upon new foundations, and rather than dig out the old plates and bolts we sawed the bolts off with a hack-saw even with the floor line.

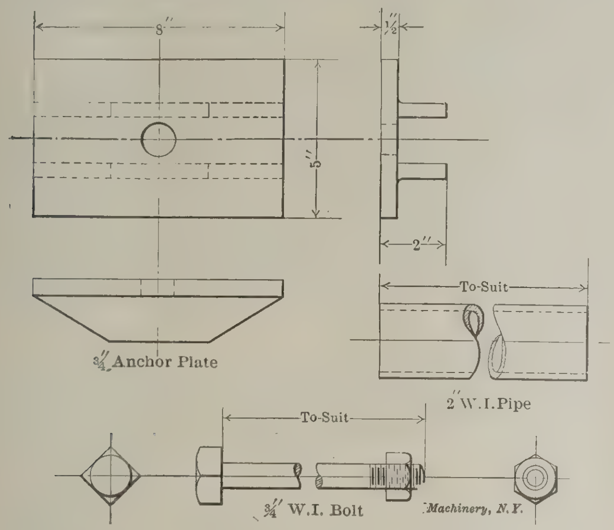


Fig. 1. Old Style Anchor Plate for Square Head Bolt.

In setting up the new foundations the bolts would in some cases be too long and in places too short after the floor was leveled. To overcome this difficulty the bolt and plate shown in Fig. 2 were designed. With this bolt a square nut is set on the little shelf, shown by the section lining, where the projecting ledge at each side holds it in place. A straight rod threaded on both ends is screwed into it. The ring on top of the plate keeps the pipe centered around the bolt while the cement or grouting is being poured. When the bolt is short all that is necessary to do is to cut off a new rod of the required length, thread it, and place it in the pipe, where it may be screwed into the nut, which is so securely enclosed that it cannot be lost. When the machinery is moved the bolt can be taken out and used in the new foundation. E. C. F.

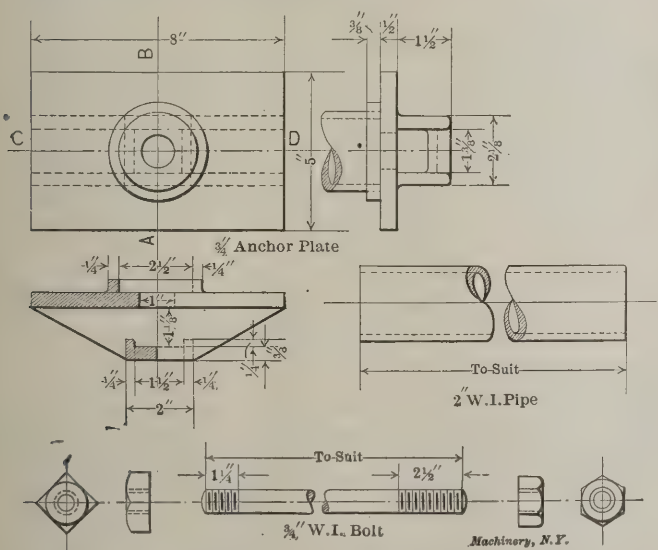


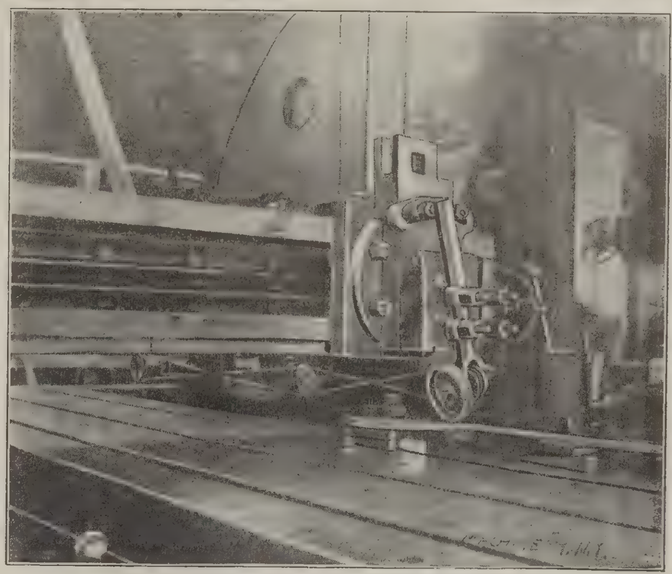
Fig. 2. Improved Anchor Plate for Square Nut and Threaded Rod.

THE PROPER METHOD OF MAKING SURFACE PLATES.

In order to have straight and true beds and platens on the machine tools manufactured to-day, it is essential to have good surface plates to scrape them in by. There has long existed an erroneous idea as to how to make a good surface plate. Some contend that a good proof staff or surface plate can be made by scraping in two plates together, until they show a good bearing. This is not right. A proof staff made after such a fashion is not necessarily true. Inaccuracies in the one plate will often be concealed by corresponding inaccuracies in the other. The proper way to obtain a good surface plate or proof staff is to have three plates carefully planed up and then worked with as follows, numbering the plates one, two and three. First, fit No. 3 and No. 2 to No. 1; you have now No. 2 and No. 3 alike; second, fit No. 2 and No. 3 by scraping as much on one plate as the other; third, fit again No. 1 to No. 2; fourth, fit again No. 3 to No. 1; fifth, fit No. 2 to No. 3 together by scraping as much on one plate as the other. Continue this procedure carefully until No. 1 will fit No. 2 and No. 3, and No. 2 will fit No. 1 and No. 3. You have now three plates that are accurate and which can be relied upon. Having three good plates, one can be laid aside as a guide to be used only for testing the other plates at frequent intervals, while the other plates can be used in active service. J. J. JENKINS.

SURFACE GRINDING ON THE PLANER.

The accompanying cut shows a surface-grinding job done on the planer. The work seen strapped on the bed is one jaw of the guide for an endless steel knife, which runs over pulleys exactly as does a band saw, and is kept perfectly straight on the tangents by these guides. The latter are made of cast iron, faced with hardened steel, and have to be trued up every few months because of the constant motion of the knife. To do this with a tool was out of the question, so our foreman, Mr. S. F. Cronk, solved the problem with the outfit shown, constructed entirely from odds and ends. In the toolpost of the planer is secured the shank of the holder for a small grinding wheel spindle and on the rear of the housing is clamped a jack-shaft having a grooved pulley at one end and a flanged pulley at the other. This shaft is driven by a one-inch belt, which can be seen inside the reverse belt and which passes over the large pulley on the countershaft. The round belt shown under the cross-rail drives the grinding wheel spindle from the jack-shaft. The cutting is done by the body of the cup-shaped wheels which have served their usefulness on the cutter grinder. As can be seen, the photograph was taken about on the level of the planer bed, the machine itself being a 15-foot New Haven planer with clutch drive.


Surface Grinding on the Planer.

Middletown, N. Y. DONALD A. HAMPSON.

ANOTHER MATHEMATICAL "PROOF."

Having realized that my attempt to disprove Euclid was met with stern opposition, and that the readers of MACHINERY bestowed upon me ridicule rather than compassion, which lat-

ter would probably have been a more properly selected sentiment in the case, I have promised myself not to try to aspire to scientific honors in the realms of geometry; this, however, does not say that I am going to "give up," but simply that I intend to switch over to a more congenial territory. The laws of geometry are evidently a little too rigid to be tampered with; but by means of algebra one can prove almost anything. While the readers of MACHINERY did not favorably accept of my "proof" that a right angle equals one that is larger than a right angle, there may be some difference of opinion as to the fundamental principles of algebra if I can prove that 1 equals 2 by the use of simple algebraic operations. Assume that

$$a = b.$$

Multiply both terms with a, in which case

$$a^2 = ab.$$

Subtract from both terms b^2. The remainders are then equal:

$$a^2 - b^2 = ab - b^2.$$

This expression can be written in the form

$$(a + b)\ (a - b) = b(a - b).$$

Divide both members with $a - b$; the quotients are then equal:

$$\frac{(a + b)\ (a - b)}{a - b} = \frac{b(a - b)}{a - b}.$$

Carrying out the division we have

$$a + b = b.$$

But a is assumed equal to b. Thus

$$b + b = b, \text{ or } 2b = b.$$

Divide both terms with b and we have

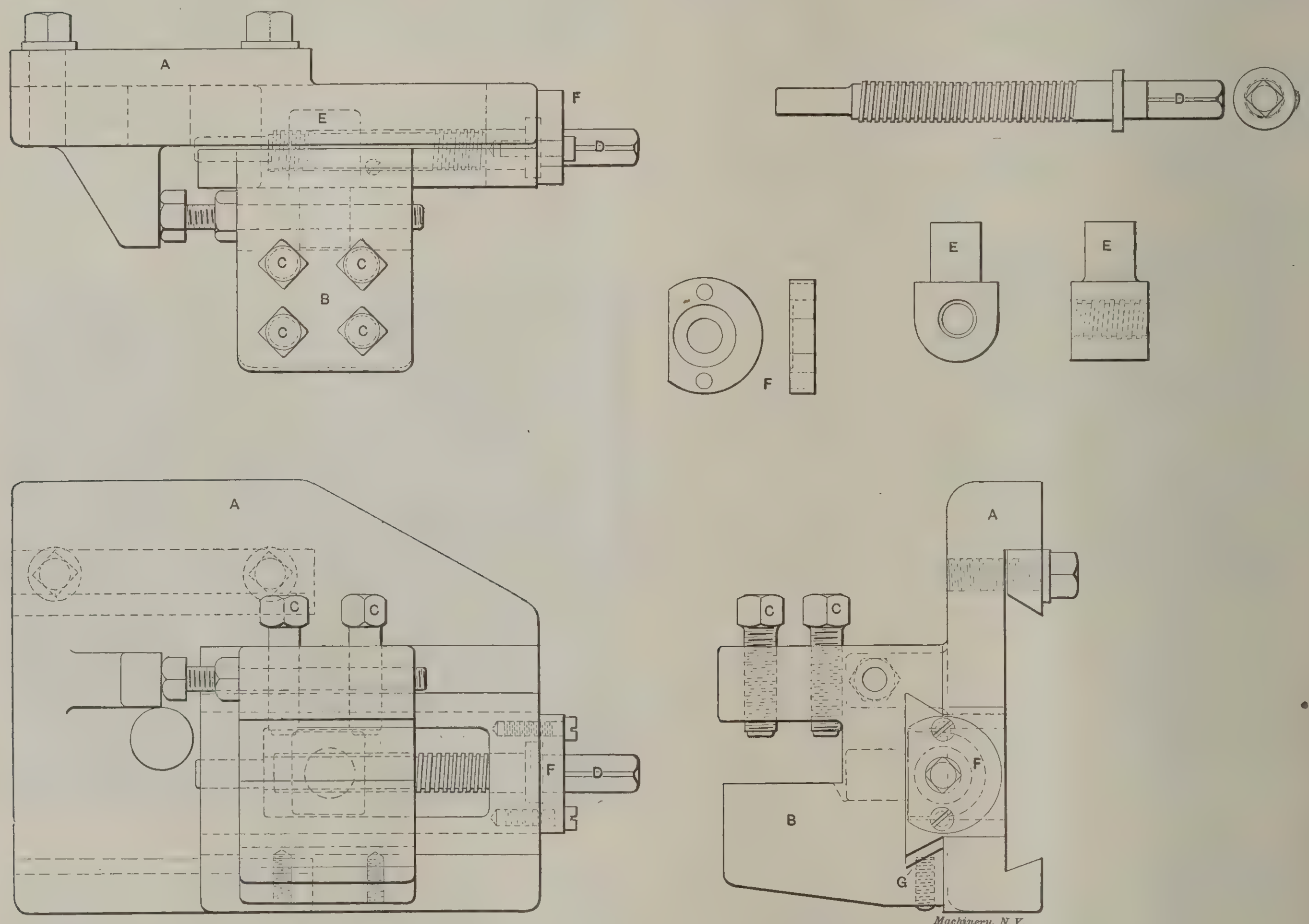
$$2 = 1.$$

Whoever invented the algebraic operations made use of is not known, but the honor is supposed to belong to an Arab whose name is not preserved to posterity. Perhaps that makes it safer to question his methods than in the case of Euclid. I promise I shall never attack his conclusions any more. But, by the way, I have a scheme of perpetual motion which is not yet patented. Any person with sufficient capital for exploitation may have it for the asking. R. S.

TOOL-HOLDER FOR CHUCKING IN THE SCREW MACHINE.

The accompanying cut shows a tool used in connection with chucking work on a 2-inch screw machine designed for machining round bar stock only. On this machine, when it was necessary to use a chuck to hold pieces, the cross-slide of the machine was thrown out of service, both on account of the large swing of the chuck body and the short length of the longitudinal feed screw of the machine. Moreover, the capacity of the regular box tools in the turret was but 2¼ inches. For these reasons the following fixture was designed.

Referring to the cut, *A* represents a steel casting which fits on the turret of the machine. The tool carrier, *B*, which is a steel forging, finished all over, is provided with four set-screws, *C*, and receives its feed from the square-threaded screw *D*, which in turn is operated by an ordinary crank. By using four clamping screws for holding the tools, it becomes possible to do both end and side forming, facing and turning. The feed screw *D* is a running fit in the bronze nut *E*, allow-



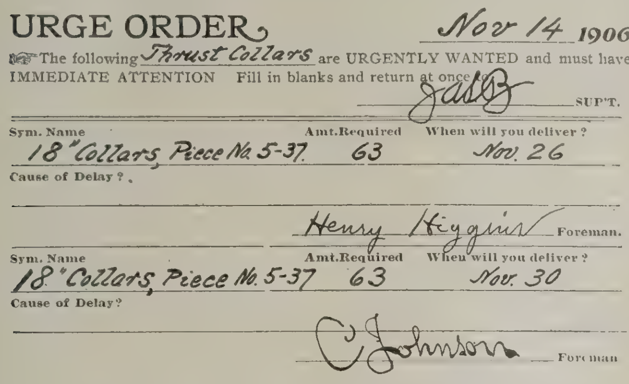
Tool-Holder for Chucking in the Screw Machine.

ing the feed screw to bear on the ends alone, thereby preventing binding or locking. The end thrust of the screw is taken up by the collar *F*, which is held by two fillister head screws. By placing the adjustable gib *G* on the under side, an easy travel is secured for the tool carrier when in operation. The work performed consists mostly of small special castings varying in diameter from one to seven inches. In this manner the fixture becomes universal to a great extent, and is rendered particularly valuable on account of the shop lacking a turret lathe designed for chucking rather than for plain screw machine work. W. T. M.

"URGE ORDER" SYSTEM.

The cut herewith shows a card of an "Urge Order" system used by The R. K. Le Blond Machine Tool Co. for getting out rush parts, or pieces that are urgently needed for completing a lot of machines. This is not an integral part of the regular shop system but is supplementary to it, and used only for those pieces which have preference over all other work com-

ing through the shop, and for this purpose it has proved very effective. It is the custom to gather all the machine parts, screws, etc., needed to erect a lot of machines several weeks before they are to be erected upon trucks in the stock room to be delivered into the shop when needed. It frequently occurs that some parts that are wanted are not on hand in the stock room at this time, and the object of the system is to get


URGE ORDER Nov 14 1906

The following Thrust Collars are URGENTLY WANTED and must have IMMEDIATE ATTENTION Fill in blanks and return at once.

SUP'T.

Sym. Name	Amt. Required	When will you deliver?
18" Collars Piece No. 5-37	63	Nov. 26

Cause of Delay?

Henry Higgins Foreman.

Sym. Name	Amt. Required	When will you deliver?
18" Collars, Piece No. 5-37	63	Nov. 30

Cause of Delay?

C Johnson Foreman

"Urge" Orders of the R. K. Le Blond Machine Tool Company.

these through at once. On these parts work is usually already commenced in the shops, and they are in some partial state of completion.

The number of parts needed is stated on the urge order with the name or mark of the pieces. The order or card is taken to the foreman in whose department the work is. The foreman fills in the date when he will deliver same to the next department and signs his name. If for some cause he cannot promise a delivery owing to the lack of some tool, jig, etc., that he might be waiting for, he indicates this reason on the card. The card is then returned to the superintendent's office, inspected and filed in a dated card index. This index is the usual kind used for similar purposes and has tab cards numbered from 1 to 31. The cards are received daily, and on the day marked on the card it is checked and taken with the work to the next department, to be again dated and signed by the foreman. This is continued until the work is delivered to the stock room. As will be seen, this forms a record of all promises made by the foreman and keeps a constant check on the work until it is finished. W. G.

JIG FOR PLANING CONNECTING-ROD BRASSES.

Having at different times derived ideas from other jig and tool designers, I hereby submit drawings and description of a jig designed this last summer with the hope that someone may derive an idea from it. The pieces to be milled were connecting rod brasses for Corliss engines from 30 x 36 inches down to 10 x 12 inches; two different sizes of this jig were sufficient for all.

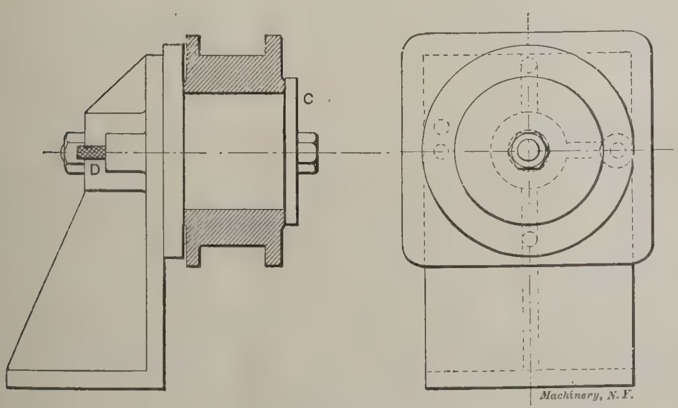


Fig. 1. Jig with Work in Place.

The jig consists mainly of two pieces, as shown in Fig. 2, the angle plate and the revolving faceplate. The jig is so arranged that all four sides, one of which is planed for a wedge, could be milled at one setting by simply turning the faceplate until the index pin engaged in the proper hole. The hole off center is for locating the proper angle when milling the wedged side. The angle plate *A* is made quite stiff, because it has to take the entire cutting strain, without springing to any extent. The faceplate *B* is finished all over. The hole in the center for the studs for holding faceplate and work in position was drilled in the lathe to insure accuracy. It had been our great trouble in the past that we could not with the cheap labor we use, get our work milled square with the bore, which necessitated a lot of filing and chipping. The washer *C*, Fig. 1, is used for locking plate after swinging

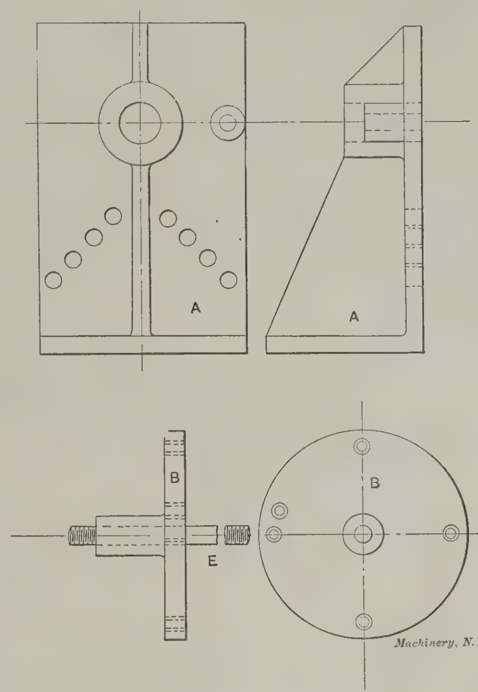


Fig. 2. Details of Jig.,

into position and engaging index pin *D*. The holes into which the index pin engages are bushed with taper bushings, made of tool steel and hardened and lapped to fit. The work is centered on bushings the same size as the pin on which the brasses are to run. This enables the operator, by squaring one side, to chuck his work accurately, and all work done is interchangeable. The eight holes drilled diagonal in the angle plate are for the purpose of putting stops to hold the work after it is clamped in position as an additional precaution against slipping. Of course this jig can be improved upon, but at present it is doing the work for which it was designed, doing it better and in one-third of the time of the old way, *i. e.*, using special parallels. R. G. D.

THE STRENGTH OF A MOUTHPIECE RING AND COVER.

In relation to the above article in the November issue (Engineering Edition, page 119) I wish to call attention to a part of a mouthpiece ring which sometimes has proven out to be designed too weak, referring to the danger of failure of the flange at the corner of the gasket groove. I notice, in the article referred to, the words: "The possibility of this would be a rather difficult thing to calculate with assurance, but good judgment would seem to indicate that the casting is none too strong at this point." I think the manner of figuring the strength at this point, which I present, will be of value to those interested in the design of such vessels.

At the left of the cut is shown the ring as suggested. The load ($L + N\ E$, see the article) is acting with a certain bending moment on the flange of the bolt circle, and trying to break it in the cylindrical area whose height is h and whose length is $2\ \pi\ r$, as shown in the right-hand figure, which is a plane development of the circumference of the ring. Considering the action as being that of a cantilever whose length l is 2 inches, breadth $b = 2\ \pi\ r = 166.5$ inches, and whose depth $= h = 1\frac{1}{2}$ inch. We may obtain the extreme fiber stress as follows:

$$\text{Bending moment} = (L + N\,E)\,l$$

$$\text{Resisting moment} = S\,Z = \frac{S\,b\,h^2}{6}$$

$$(L + N E)\, l = \frac{S\, b\, h^2}{6}$$

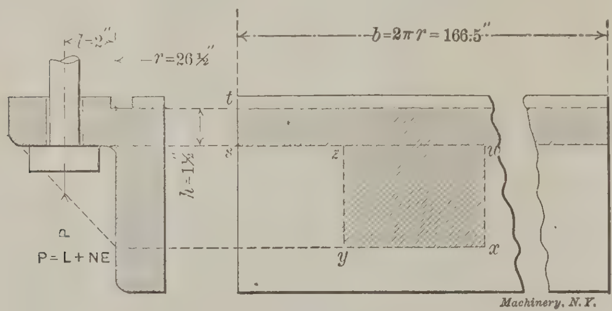
$$S = \frac{6\, l\, (L + N E)}{b\, h^2}$$

$$S = \frac{12\,(126{,}000 + 24 \times 1{,}200)}{166.5 \times 1.5^2} = 4{,}950 \text{ pounds per square in.}$$

The result of this calculation shows that the factor of safety for the flange is smaller than 5, so that it would be advisable to increase the thickness of the flange to give sufficient strength. An increase of thickness to 2¼ inches gives a unit stress of 3,640 pounds, an amount well within reasonable limits. Instead of increasing the thickness, however, flange ribs, as shown in the dotted lines in the cut, could be provided for getting a higher strength. The development in this case will give two rectangles, the upper one, $s\ t\ u\ v$, being as before, while the lower one, $w\ x\ y\ z$, has a length $y\ x$ equivalent to the total thickness of all the ribs used. Obtaining the moment of resistance of figure $s\ t\ u\ v\ w\ x\ y\ z$, the unit stress will easily be found. HERMAN GUMPEL.

Belleview, Pa.

[In calculating the strength of the flange in this manner the stress would be slightly higher even than is indicated by our contributor's figures, since he uses too small a load $(L + NE)$, as N should be 36 instead of 24. We made, at the time the article was written, a rough calculation after the manner suggested, carrying it far enough to show that the original design was weak in this respect. We believe,



Finding the Strength of a Flange.

however, that the actual stresses would be somewhat less than would be indicated by a simple solution of this kind. The tendency to bend is resisted, not only by the deformation of the fiber when the section is considered as a beam, but also by the compression of the outer fibers of the flange the moment any bending takes place. We agree with our contributor, however, that the construction is none too strong at the point in question and it could be improved by thickening the flange or by adding ribs. The value of ribbing in a casting of this sort, on general principles, is shown in Prof. Benjamin's article on the bursting strength of cast-iron cylinders in MACHINERY, Engineering Edition, November, 1905.—EDITOR.]

THREADING TOOLS AND THREAD GAGES.

E. A. Johnson.

Of all tool-makers who are employed in the manufacture of taps and dies, there are but few outside of the shops where standard thread plugs and templets are made for the trade who understand how to produce an accurate thread. By an accurate thread I do not mean a precision screw, but a thread which, while a commercial possibility, will measure within a fraction of a thousandth inch of being theoretically correct. It is probably cheaper in a majority of cases to buy gages rather than to make them, but many shops prefer to make their own, especially where the pitch is not standard. In such shops, when a new gage is to be made, the work is usually intrusted to a man who has the reputation of being a "crack-a-jack" at thread cutting, though he may not have the first idea as to what his gage really measures when finished. For such cases the following is intended as a guidance.

The chief requisites for cutting a correct thread are correct threading tools, a correct setting of the tool, and a lathe with a reasonably accurate leadscrew. In making the thread tool a correct 60 degree angle gage is necessary. To produce such a gage first plane up a piece of steel in the shape of an

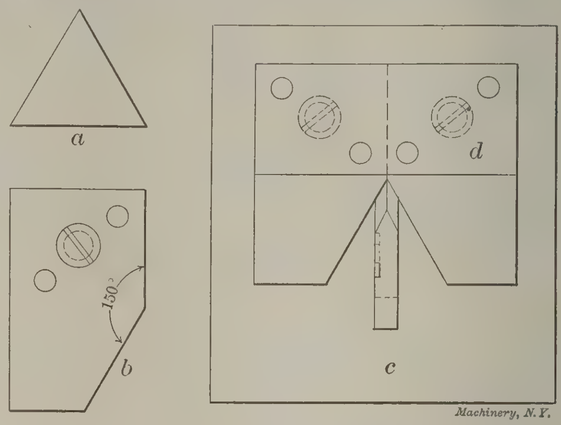


Fig. 1. Gages for making Threading Tools.

equilateral triangle as shown at a in Fig. 1. After hardening this triangle, grind and lap the edges until the three corner angles prove to be exactly alike when measured with a protractor. This is now the master gage. To produce the female gage make two pieces, one right hand and one left, like that shown at b in Fig. 1; harden them and lap the edges that form the 150 degree angle so that they are straight, and square with both sides. When this is done the two pieces should be screwed, and doweled to a backing plate d as shown in Fig. 1, using the master triangle to locate them, thus producing a practically perfect female gage.

In making up the tool some form of cutter to be used in a holder should be chosen in preference to a forged tool on account of convenience in handling and measuring and the feasibility with which it may be re-ground without destroying

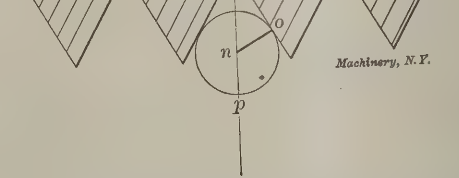


Fig. 2. Measuring the Angle Diameter of a Thread.

the shape. The tool should be made so that the top will stand level when in the holder and the clearance should be about 15 degrees, which is ample for a single thread unless the pitch is very coarse. With that amount of clearance the included angle between the sides of the tool in a plane perpendicular to the front edge is approximately 61° 44′. The tool should be planed to that angle as nearly as is possible by measuring with a protractor, then, to test its accuracy, it should be placed top down on a flat piece of glass c and tried with the 60 degree gage as shown in Fig. 1. After lapping the tool until it shuts out the light when tried in this manner, the angle may be considered as nearly correct as is possible to obtain with ordinary means. To adapt the V-thread tool thus made to cut the United States standard form of thread, it is only necessary to grind off the sharp edge an

EUGENE A. JOHNSON was born in Michigan, 1872. He served his apprenticeship with A. F. Bartlett & Co., Saginaw, Mich., and afterward worked for the P. M. R. R., Mitts & Merrill, Veeder Mfg. Co., A. B. Dick & Co., Illinois Sewing Machine Co. and others. At present he is assistant foreman in the screw machine equipment department of the Pratt & Whitney Co.

amount equal to one-eighth of the depth of a V-thread of the required pitch, or for 20 threads per inch $\frac{0.866}{20} \times \frac{1}{8} = 0.0054$ inch. To test the accuracy of this grinding a piece of steel should be turned up to the correct outside diameter and a short shoulder turned down at the end to the correct diameter of the bottom of the thread; then the piece is threaded and the tool fed in until the flat of the tool just tangents the shoulder. Then cut a nick in the edge of a piece of sheet steel with the threading tool. This sheet steel piece is now applied like a gage to the threaded cylindrical piece. If the nick in the sheet steel fits the thread so that it shuts out the light the flat of the tool is correct.

In preparing a plug gage for threading it should be made the same as the cylindrical test piece above with a part turned down to the root diameter of the thread except that for V-thread it is customary to leave the shoulder 0.005 inch large on account of the impossibility of producing a perfectly sharp point on the tool. The thread tool should be set level, with the top at the same height as the center line of the spindle of the lathe, otherwise the correct angle will not be reproduced. After a master plug has once been produced, it is not necessary to turn down a portion to the root diameter of the thread as the work can be compared with the master plug by means of a micrometer fitted with either ball or V points for measuring in the angle of the thread.

It occasionally happens that a tap is to be threaded, or other external threading is to be done, of an odd size or pitch where it is desired to originate a master plug. In such cases the writer uses three wires for measuring the angle of the thread, placing one wire in the angle of the thread on one side of the piece and the other two on the opposite side, one on each side of the corresponding thread, measuring over the whole with a micrometer. The formula for the micrometer reading is obtained as follows: In Fig. 2 assume that m is the bottom of a V-thread, the circle showing one wire in place. Then angle $a = 30$ degrees; sin 30 deg. $= 0.5$; $\frac{no}{0.5} = mn$ or $2no = mn$. As no and np are radii of the same circle, it follows that $mp = 3no = 1\frac{1}{2} \times$ diameter of wire. Multiplying by two to add a length mp for the opposite side gives $2mp = 3 \times$ diameter of wire. Hence for V-thread,

$$\text{Dia. of screw} - \frac{1{,}732}{\text{No. thds. per in.}} + (3 \times \text{dia. of wire used})$$

$=$ micrometer reading.

For U. S. form we have to take into account the flat at the bottom of the thread, so instead of using the U. S. constant 1.299 we add to it $\frac{1}{8}$ of 1.732 or 0.2165 giving as a constant 1.5155, making the formula:

$$\text{Dia. of screw} - \frac{1.5155}{\text{No. thds. per in.}} + (3 \times \text{dia. of wire used})$$

$=$ micrometer reading.

E. A. Johnson.

Hartford, Conn.

[The subject of measuring threads with the wire system was treated at length in Machinery, January, 1904, in an article by Joseph M. Stabel entitled "Measuring External Thread Diameters."—Editor.]

DRAWING TABLE FOR A TECHNICAL SCHOOL DRAFTING ROOM.

F. H. Sibley.

Following is a description of a drafting table that is giving first-rate satisfaction for college drawing room work. Its advantages are strength, compactness and the utilization of what would otherwise be wasted space beneath the tables. The table was designed for the drafting room of the mechanical department at the Case School of Applied Science, and has been in use for about two years. Conditions here made it necessary to construct a cabinet table containing drawers for instruments and lockers for boards and T squares. As several squads of men have to be accommodated at different periods, at the same set of tables, these tables had to be designed so as to discourage the tendency on the part of some students to "swipe" their neighbors' instruments and drawings, and at the same time allow a number of men to use the same desk.

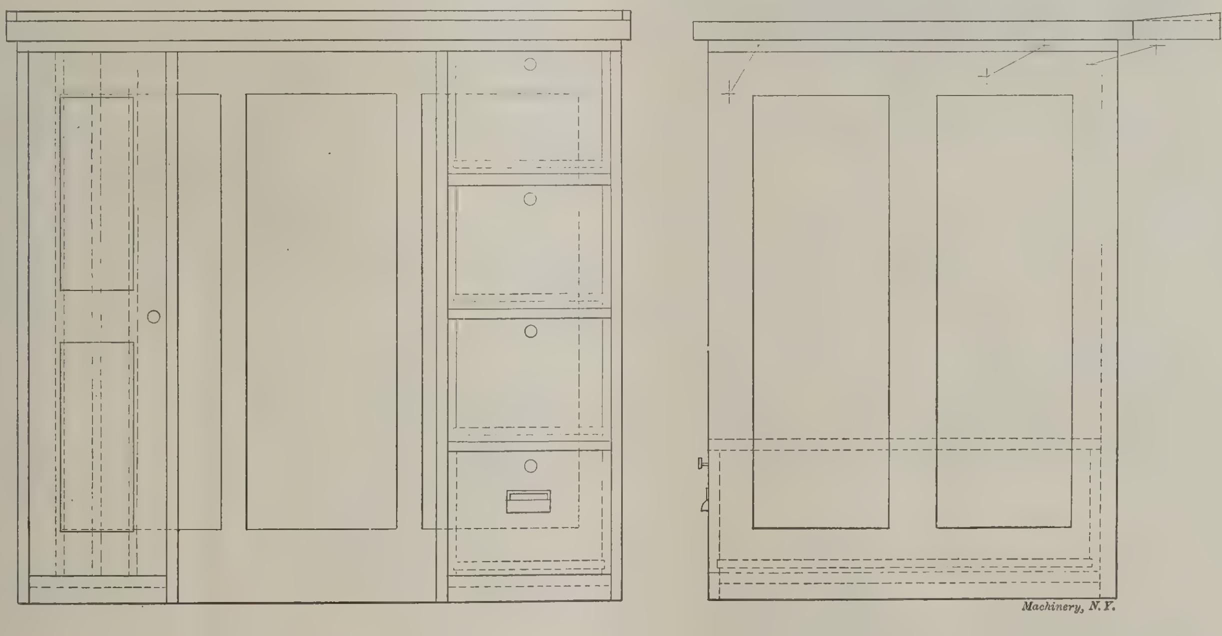


Fig. 1. Front and Side Elevation of Student's Drawing Cabinet Table.

The halftone, Fig. 2, shows the cabinet which has four instrument drawers on the right-hand, and a cupboard on the left-hand side, the latter containing four spaces for boards and T squares. The drawers and cupboard are fitted with combination locks, so that each student has access to one instrument drawer and four boards. Two views of the table are shown in Fig. 1. Its dimensions are 3 feet 5 inches long by 2 feet 3 inches wide and 3 feet 3 inches high to the top of the board when in the horizontal position. The material in the cabinet part is $\frac{7}{8}$ inch oak lumber stained a dark color and varnished. The panels in the back and at the ends are $\frac{1}{2}$ inch oak.

F. H. Sibley was born in North Oxford, Mass., 1872. He was educated in Brown University and Case School of Applied Science. He served a shop apprenticeship in Worcester, Mass., and has worked for the city of Providence, Geo. Lawley & Son Corporation, Westinghouse Switch & Signal Co., West Shore & Michigan Southern R. R. in the capacity of assistant engineer, draftsman, calculator, etc. He is at present instructor in machine design in the Case School of Applied Science, Cleveland, Ohio.

The instrument drawers are 7 inches deep, 10 inches wide and 2 feet 1 inch long. They are made of soft wood ½ inch thick, except the front, which is of ⅞ inch oak. Besides the lock already mentioned each drawer has a pull with a slot in it for the occupant's name. A stop is fastened to the bottom so that the drawer cannot be entirely removed from its place. This prevents any one from getting at the instruments in the drawer underneath. The board locker is 10 inches wide and extends nearly the whole height of the table. The four board spaces are each 2 inches wide, separated by ½-inch vertical slats. The door is of ⅞-inch oak with ½-inch panels and is hinged on the left-hand side so that it swings clear of the worker's knees. The space between the locker and the tier of drawers is 17 inches wide, allowing ample

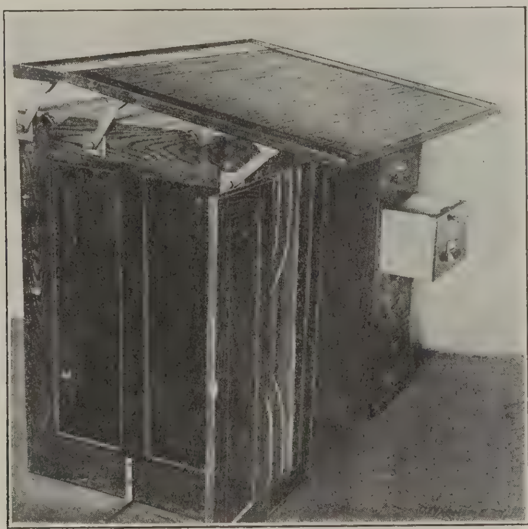


Fig. 2. Drawing Table used in Case School of Applied Science, Cleveland, Ohio.

room to work sitting at the table. A foot rest made of 1-inch gas pipe is to be placed across this space about 6 inches above the floor.

The cabinet is fastened to the floor with two malleable iron brackets and screws. Its top is of soft wood ⅞ inch thick and above it is an adjustable drawing board mounted on iron links. This board is made of butternut wood 1 inch thick. Its dimensions are 3 feet 8 inches by 2 feet 6 inches, and it has strips 3 inches wide jointed to each end to prevent warping. Fastened to the back of the board with 4-inch strap hinges is a leaf with a flange around it for holding instruments and ink bottles. The leaf is attached to the cabinet by links in such a way that when the board is thrown forward to the inclined position the leaf is lifted, but remains horizontal.

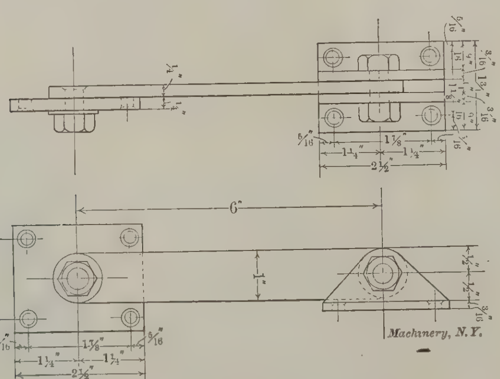


Fig. 3. Details of Link Arrangement.

A detail of the link and its fastenings is shown by Fig. 3 and the arrangement of the links on the board and cabinet in the two extreme positions is illustrated by Fig. 4. The lower end of the link is fastened to a malleable iron plate with a ½-inch bolt, the plate being counter sunk on the side next to the cabinet and the bolts riveted down flush. The plate is then screwed to the cabinet. The upper end of the link is fastened in a small brass or malleable iron bracket with a ½-inch bolt having a nut and washer on each end; in place of the bolt a ½-inch pin having a split cotter at each end has been used. The bracket is screwed to the under surface of the table.

The links are all made the same length, but it is evident that by varying their length and position, the adjustment of the board can be varied to suit the user. In the table here

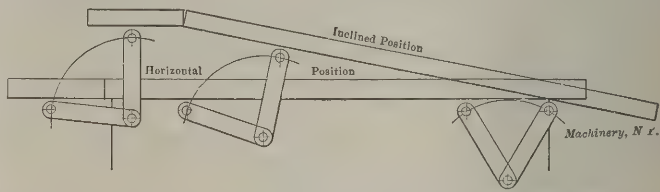


Fig. 4. Diagram showing Extreme Positions of Links and Board.

described the board is thrown forward 7 inches and raised 3 inches at the back, giving it a slope of about 12 degrees. For maximum strength and stiffness the links under the leaf at the back ought to be in nearly a vertical position when the board is thrown forward. The board should also, when in this position, have a solid bearing on the front edge of the cabinet for if supported by the links alone it will not be steady.

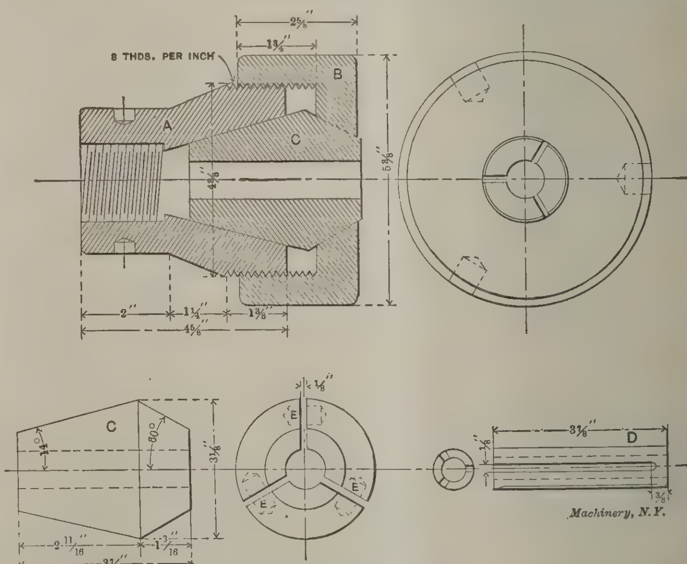
These tables were built by contract for $14.50 each, exclusive of the iron work. The cost of locks and fittings, links, hinges, etc., with labor for putting on same amounted to about $4.00 each, making the total cost of each table about $18.50.

In operation, four men, working at different periods, are assigned to a table, a book list of the lock combinations is kept, with the user's name opposite the combination. The scheme makes it possible to accommodate a varying number of students, without filling up the drafting room with lockers which are in use only a small part of the time. By locking together the drawing boards in groups of four, space is greatly economized at the same time as drawings may be left on them over night without much danger of loss.

Cleveland, O. F. H. Sibley.

COLLET CHUCK.

The chuck shown in the accompanying cut consists of three parts, the sleeve *A*, the knurled nut *B*, and the split collet *C*. The sleeve *A* is threaded to fit the spindle of the lathe and



Collet Chuck for use in Lathe.

bored to receive one end of collet *C*. The nut *B* is bored to receive the opposite end of the collet *C* and has three holes drilled in the outside for the spanner wrench. The tightening of this nut forces *C* against the taper in *A*, thus gripping the work. Several collets of different bores should be made for different sizes of stock. Sizes under ⅞ inch can be conveniently held by making steel sleeves as shown at *D* in the cut. The collet *C* is split in three parts and drilled, as shown at *E* in the detail of the collet, for coiled springs, which force the jaws apart when the nut *B* is loosened, thus allowing the work to be removed easily. H. H. Wilkinson.

Salem, Ohio.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

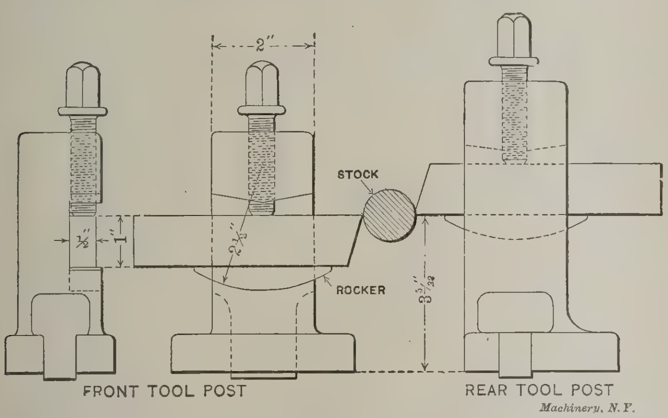
CLEANING TOOLS WITH AN INK ERASER.

A very convenient way of removing rust and brightening surfaces of tools, such as steel scales or brass and German silver protractors, is to rub the surface with a common ink eraser. It does not scratch the surface as emery cloth does; it is always at hand for a draftsman and would also be appreciated by a machinist. WM. H. KELLOGG.

Chicago, Ill.

IMPROVED TOOLPOST FOR THE SCREW MACHINE.

The toolposts on the Garvin screw machine cross slide were giving me a great deal of trouble both in regard to failing to hold the tool rigidly, and on account of the breaking off of

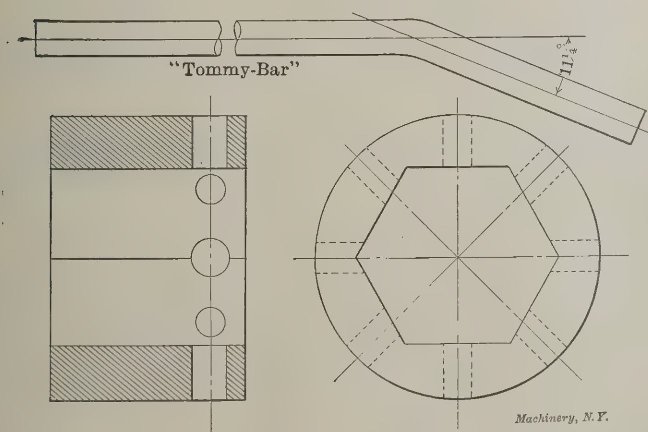


the part which fits in the T-slot, due to the pressure sidewise. I therefore decided to design a toolpost which would stand up under all conditions with the result shown in the accompanying cut. C. W. PUTNAM.

New York City.

SIMPLE SOCKET WRENCH.

I had occasion to tighten a ¾-inch nut in a position where an ordinary wrench could not be used. The socket shown in the cut was made, having a hexagon hole for the nut. Through the top of the socket eight holes were drilled 45 degrees apart for a steel rod which was used as a handle or "tommy-bar." This pin, being bent at an angle of 11¼ degrees, enabled the



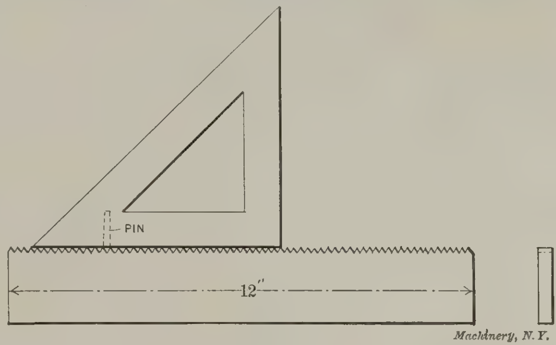
nut to be turned one-sixteenth of a turn for each position of the pin, and thus permitted the nut to be tightened with a very short angular movement of the handle.

Auburn, N. Y. JOSEPH ROACH.

[This scheme is a good one for the purpose described. We recently saw it in use in the Schenectady plant of the General Electric Co. on 3-inch nuts, these being located in a generator frame where an ordinary wrench could not be employed. The simplicity of construction, ease of operation and effectiveness will commend this form of wrench to all who have use for such a tool.—EDITOR.]

SECTION LINER.

The accompanying cut shows the principle of a section liner which, although simple, answers the purpose fully as well as some of the more complicated and expensive arrangements. It consists of a piece of brass or any metal 12 inches long with threads cut on one side as shown, about 40 threads



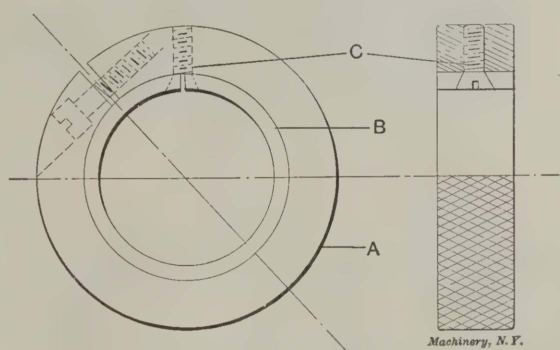
to the inch, a wooden triangle and a pin driven in as indicated and filed to fit the thread into which it is to engage. The other boys and myself have used it and find it to be a good thing. JOHN H. CRAIGIE.

Boston, Mass.

ADJUSTABLE RING GAGES.

There are plenty of precise mechanics who will say that adjustable tools and gages are unsafe, and that because of this particular feature some workmen are apt to get an adjustment over or under size and spoil something. While this really is true in a measure, the same workman could, with a new sharp tap or reamer, make a hole too large, or too small with one that was worn and dull. Adjustable tools are a great help and if properly used will never cause trouble.

The cut shows one of the most satisfactory adjustable ring gages I know of, having used this form quite a number of years and prefer it to others. It is adapted for either thread



or plain gages, being used in both forms. *A* is a soft split steel ring. *B* is a split tool steel ring, hardened, ground, and lapped. The cylindrical truth of the gage remains perfect at different adjustments. The adjusting is done by the screw *C*, which should have a wood screwhead, 30 degrees included angle. This gage is both a convenience and a time saver—a practically solid gage in a few minutes changed from a standard size to several thousanths inch plus or minus. After the gage is adjusted to the desired size, which is easily and quickly done, it is as substantial as a solid gage. M. S. W.

PERMANENT SET OF SPIRAL SPRINGS.

The question and answer regarding spiral springs in the November issue of MACHINERY interest me. Evidently "F. S." met difficulty in attempting to prevent the spring from taking a permanent set. I should suggest that the spring be manufactured with an increased pitch, so that after hardening and tempering the permanent set may be taken out by compressing solid. If the spring still remains too long, a little more tempering will bring the desired result. It will be impossible by any method of hardening or tempering to prevent a spring of the dimensions given from taking a permanent set. Furthermore, do not consider that closing the coils tightly together will take out the entire set, but the spring must be compressed solid for ten or fifteen hours before the permanent set can be entirely overcome. A.

SHOP RECEIPTS AND FORMULAS.

A DEPARTMENT FOR USEFUL MIXTURES.

This page will be used for the publication of shop receipts which the contributors know from experience to be practicable. Nearly all readers of MACHINERY can add something, and it is desired that they use this page as a medium for exchanging useful formulas. It makes no difference if they are old and supposedly well-known, provided they have not already appeared in this department.

283. MALLEABLE BRASS.

Brass which possesses malleability in a high degree can be obtained by alloying 57 parts of copper with 43 of zinc.

Pittsburg, Pa. U. PETERS.

284. STEAM PIPE CEMENT.

Mix equal parts, by weight, of oxide of manganese, pipe clay and white lead, ground with linseed oil varnish.

West Somerville, Mass. E. H. McCLINTOCK.

285. TO TURN VERY HARD IRON AND STEEL.

Use a drip can for the tool with the following solution: petroleum, 2 gallons; turpentine, 1 gallon, and 2 ounces of camphor. J. H. HOLDSWORTH.

Toronto, Canada.

286. TO BLACKEN ARTICLES WHICH ARE NOT SOLDERED

Heat the article to a low heat and dip into a solution of nitrate of copper, made by dissolving copper in nitric acid. Then heat the piece dipped over a spirit lamp or Bunsen burner until from greenish color it finally turns black.

Bridgeport, Conn. H. A. SHERWOOD.

287. ALLOY FOR FILLING HOLES IN CAST IRON.

Melt together 9 parts of lead, 2 parts of antimony, and 1 part of bismuth, and pour this mixture into the hole, first somewhat warming the hole. This alloy possesses the quality of expanding when cooling, hence becomes solid in the holes when cold. E. J. BUCHET.

Dubuque, Iowa.

288. MIXTURE FOR HARDENING SPIRAL SPRINGS.

The following oil bath mixture gives excellent results for hardening spiral springs: Two gallons best whale oil, 2 pounds Russian tallow, and ½ pound rosin. Boil the tallow and the rosin together until dissolved; add the whale oil and stir up well, and then it is ready for use.

Birmingham, Eng. W. R. BOWERS.

289. TO CASEHARDEN CAST IRON.

To caseharden cast iron use a pot of suitable size for the piece, packing it in with 2/3 raw bone and 1/3 charcoal ground to about the same size as the bone. Seal the pot cover with fire-clay and place in a furnace and run it about 5 hours. Then take out the work and dip in oil or water.

E. W. NORTON.

290. TO TURN ALUMINUM.

To produce a smooth surface when turning aluminum use kerosene oil for a lubricant. If turning in a turret lathe provided with an oil pump, mix the kerosene oil with lard oil, 1 part of lard oil to 3 parts of kerosene, as kerosene itself is too thin to be fed through the ordinary oil pump without being mixed with a more heavy flowing fluid. Kerosene oil is also the best lubricant for use in boring, threading and reaming aluminum. JOHN C. MONRAD.

East Hartford, Conn.

291. TO CLEAN TRACINGS.

Tracings that have become badly soiled from handling or other causes, may be easily cleaned by thoroughly sponging the cloth with benzine or gasoline. Kerosene will serve the purpose, but is not so good. It does not injure the cloth in the least, but on the other hand has the effect of re-establishing the color of a much used tracing, and will remove pencil marks perfectly. When some compound has been used on the tracing to remove the ink lines, leaving a sticky and gummy surface, benzine will quickly clean and dry the affected portion, so that it can be worked over again.

Olney, Ill. T. E. O'DONNELL.

292. TO COAT IRON WITH COPPER.

Polish the iron by rubbing it well with cream of tartar, and afterward with charcoal powder, and place the metal in hydrochloric acid diluted with three times its volume of water, in which a few drops of a solution of sulphate of copper is poured. After a few minutes withdraw the iron and rub with a piece of cloth, then replace it in the solution, to which add another portion of sulphate of copper. By following on this plan the layer of copper may be increased at pleasure. Finally, immerse the iron in a solution of soda, wipe clean and polish with chalk. The coating thus obtained will be as firm and durable as that deposited by the electrotype process.

Pittsburg, Pa. U. PETERS.

293. STEEL BLUE ENAMEL.

A steel-blue enamel suitable for applying to steel and also other metals to give them a steel-blue polished surface, may be made in the following way: Dissolve 1 part of borax in 4 parts of water. Macerate 5 parts bleached shellac in 5 parts of alcohol. In a small quantity of alcohol dissolve some methylene blue of sufficient amount to give the color desired. Heat the first or watery solution to boiling, and while constantly stirring add the alcoholic solution. Stir until all the lumps are dissolved, and then add the blue solution. Before applying, the surface to be blued should be cleaned and brightened with emery cloth. The enamel is best applied with a soft brush. The solution may be put into a bottle and set aside for future use, provided the bottle is securely corked.

Olney, Ill. T. E. O'DONNELL.

294. TO PREVENT DRAWING TITLES FROM SMEARING OR RUBBING OFF.

A great many of our railroads and large manufacturing concerns throughout the country are using small printing presses for the purpose of putting titles on their drawings. It is titles put on in this manner with tracing cloth printing ink to which I refer. After the title has been printed on the drawing, lacquer it over with a very thin coat of French varnish (such as is used by artists). This can be best applied with a chisel-shaped camel's hair brush, equal in width to the height of the letters in the title. A good substitute where French varnish cannot be obtained is made by cutting ¼ ounce of the best grade of white shellac in ½ pint of alcohol. As either of these varnishes dry very quickly, the tracings may be used soon after the titles are put on.

Meadville, Pa. E. W. BOWEN.

295. SATIN FINISH ON ALUMINUM.

The article should first be dipped in a caustic soda or caustic potash solution—potash preferred—then thoroughly washed in clear water and dipped in a bath of concentrated nitric acid, after which it should be thoroughly washed and dried in hot sawdust. The caustic solution should be prepared in a tank provided with a steam coil and should test with Baumes' hydrometer at anywhere between 20 and 30. The length of time an article should remain in the caustic solution is a matter of judgment. The solution should attack the aluminum rapidly, and upon removing the article from the solution, the solution should boil furiously on the metal. After washing, the article should show a very black color, which turns to a silvery white finish upon dipping in the nitric acid. The best temperature for the caustic solution is at 200 degrees F., just below the boiling point. By the use of a steam coil the solution can be kept at an even temperature, and the strength of the solution can be maintained by adding small quantities of caustic from time to time. The temperature and strength of the solution are very important.

The principal point to bear in mind in washing and drying is to dry without streaks, which is accomplished if the sawdust contains no pitch or rosin.

This finish can be improved by scratch-brushing the article before dipping or by first dipping in the two solutions and then scratch-brushing and afterward dipping again. The scratch-brushing destroys the grain of the metal and reduces the possibility of the article drying with streaks.

Bridgeport, Conn. S. H. SWEET.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

36. A. L.—Please give a general rule for finding the angular setting of a milling machine head when it is required to mill a flat side on a tapered pin which shall be proportional in width throughout its length to the varying diameter of the pin. For example, what is the proper setting for the milling machine head when making four-sided reamers for standard taper pins ¼-inch taper per foot?

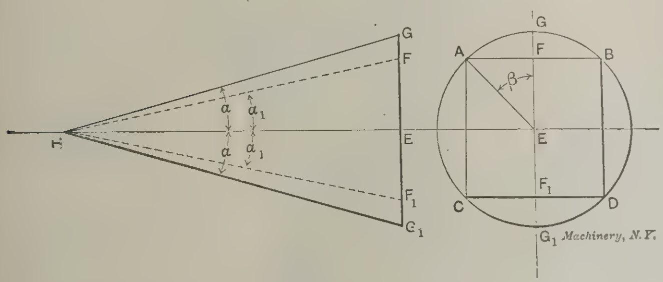
A.—Divide one-half the taper per foot by 12, and multiply the quotient by the cosine of 360 divided by two times the number of sides. The result is the tangent of the required setting of the index head. Expressed as a formula, using the symbols and lines shown in the cut we have

$$\tan \alpha_1 = \frac{GE \times \cos\beta}{HE} = \frac{\frac{1}{2}T}{12} \times \cos\frac{360^\circ}{2N}$$

α = one-half included angle of cone.

α_1 = angle made by flat with the axis or center line.

$$\beta = \frac{360^\circ}{2N}.$$



N = number of sides.

T = taper per foot.

Expressed in words, the formula reads:

$$\text{Tangent angular setting} = \frac{\frac{1}{2}\text{ taper per foot}}{12} \times \text{cosine}\,\frac{360\text{ degrees}}{2 \times \text{number of sides}}.$$

Taking the quoted example, we have:

$$\text{Tan } \alpha_1 = \frac{\frac{1}{8}}{12} \times \cos 45 \text{ degrees.}$$

$$= \frac{\frac{1}{8} \times 0.707}{12} = 0.01041,$$ the tangent of the required angle.

Referring to a table of tangents discloses that the angle is 25 minutes, or the required setting.

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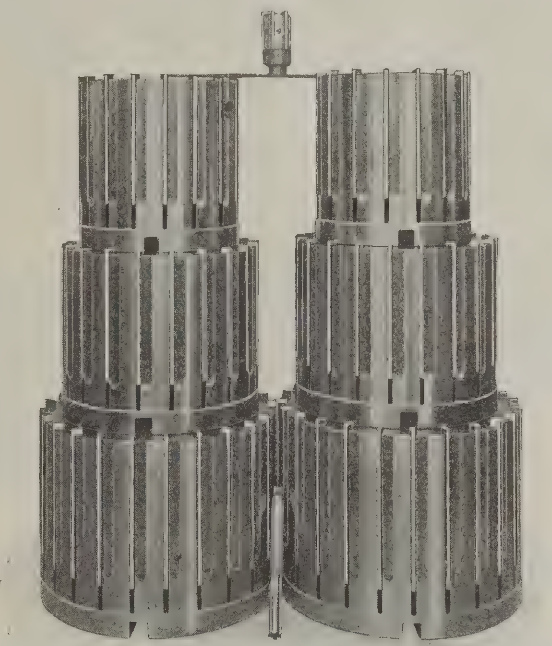
35. A. L. F.—Having given the number of teeth and the pitch angle (or edge angle) of a bevel gear, how can I find the number of teeth of the mating gear, the axes being at 90 degrees?

A.—The number of teeth in the given gear is to the sine of its pitch or edge angle as the number of teeth in the mating gear is to the cosine of the pitch angle. For example, suppose the pitch angle is 56 degrees 59 minutes and the number of teeth is 40. The sine of 56 degrees 59 minutes is 0.83851, and the cosine is 0.54488. Hence $40 : 0.83851 = x : 0.54488$, or $x = 26$, the number of teeth in the mating gear. You will observe that the result figures almost exactly 26 teeth; if it does not closely approximate a whole number then the pitch or edge angle is incorrectly given for, of course, no fractional tooth numbers can be used. The rule may be used to give both of the two possible combinations of a pair of bevel gears. Let us take for example the case of a pinion having 40 teeth, assigning to it for the moment the pitch angle 56 degrees 59 minutes, then the nearest whole number of teeth in the mating gear is 62, but the actual result is 61 and a fraction. Taking 62 as the probable number and working backward we find that the actual pitch angle of the 62-tooth gear must be 57 degrees 10 minutes. The method of finding this is simple: square the numbers of teeth in each gear, add their squares, extract the square root and divide either number of teeth by the root. The quotient is the sine of its pitch angle. To illustrate: $\sqrt{62^2 + 40^2} = 73.78$; $62 \div 73.78 = 0.84034$, the sine of 57 degrees 10 minutes. If, instead, we divide 40 by 73.78 the quotient is the sine of the pitch angle of the 40-tooth pinion, or 0.54216, the sine of 32 degrees 50 minutes. Of course it is simpler to subtract 57 degrees 10 minutes from 90 degrees, but the foregoing illustrates the process more clearly.

* * *

A GROUP OF LARGE REAMERS.

The constant extension in the range of usefulness of the adjustable reamer could not be shown in a much better way than it is in the group pictured below. Probably the dimensions of these tools will seem rather large to most mechanics, and indeed it is rather difficult to imagine just what field of usefulness has been found for adjustable reamers of this size.



Group of Large Reamers.

They were built to order, however, by the makers, Schellenbach & Darling Tool Co., Cincinnati, Ohio, and the purchaser doubtless has confidence in their capabilities. The diameters of these tools are as follows: 7¾, 8, 9¾, 10, 11¾, 12. The bores are 4 inches, 4½ inches and 5 inches respectively. The smallest shell reamer shown (at the top) is 1½ inch in diameter, the hand reamer at the bottom is 11/16 inch in diameter. The whole group weighs in the neighborhood of 1,000 pounds and certainly represents a remarkable feat in toolmaking.

* * *

One of the drawbacks to the use of wire hoisting rope has been the spinning to which it is ordinarily subject when raising a load. This is troublesome and dangerous, as oftentimes a bucket will spin so rapidly that the material loaded above the rim will be thrown off by centrifugal force and cause the injury of workmen beneath. We understand that a rope is now on the market which is not subject to this trouble, it having little or no tendency to spin as the load is raised or lowered. This example shows one the peculiar difficulties that mechanical engineers are often required to overcome. New questions in engineering are arising every day for which there is little or no direct precedent, but the solutions may often be found by analogy, reasoning from the known action of materials under similar conditions, but used for entirely different purposes.

* * *

One of the oldest blast furnace blowers in the world is undoubtedly one still in existence at the Lowmoor Iron Works in England, which according to the *Foundry Trade Journal* was built in 1791. The blast furnace itself, which was built in 1802 is also still preserved.

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

PRECISION GEAR-CUTTING MACHINERY.

The Sloan & Chace Mfg. Co., Newark, N. J., concerning whose work we have had something to say in this and the preceding issue of MACHINERY, have recently built an automatic gear cutter and an automatic rack cutter of larger size than their regular line of machinery, to meet the demand for the larger gears used in light mechanisms and instruments of various kinds. This work includes that required for cash registers, typesetting machinery, the heavier parts of typewriters, etc.; but the gear cutter shown has given such a good account of itself on comparatively heavy work that gears as large as those used in automobile construction are found to be easily within its range.

In the rack cutter shown in Fig. 1, the general design is that of the milling machine. The rack cutting spindle is driven from the main spindle by suitable gearing enclosed within a case, the axis of the cutter spindle being parallel, naturally, to the direction of the index travel of the work table. The movements of the machine, other than the rotating of the cutter, are accomplished by a vertical cam-carrying shaft, driven by the bevel gears and worm wheel shown attached to the knee. This gearing takes its motion

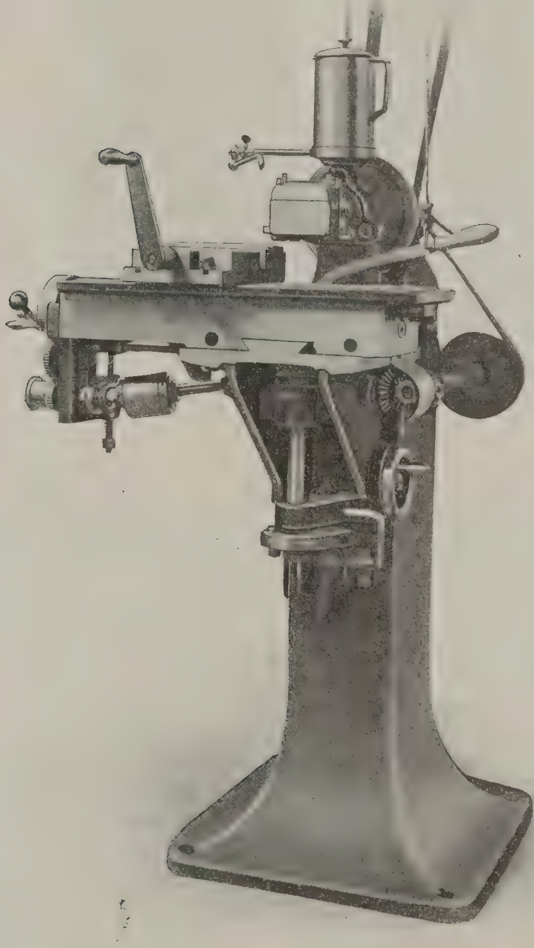


Fig. 1. Sloan & Chace Automatic Rack Cutter.

from a belt connected to the spindle at the back of the machine. The cam shaft referred to is the heavy vertical shaft journaled in bearings in the knee beneath the table; this shaft makes one revolution for each tooth cut, if a single cutter is used, or for each feeding stroke of the table if a multiple cutter is used. The cam for feeding the saddle inward for the cutting motion and backward for the return, is located at the upper end of the shaft. At the lower end is another cam, not clearly shown, which allows the knee and table to drop on the return stroke, thus relieving the cutter. This is effected by the partial rotation of a screw having a very coarse pitch, threaded into the boss projecting from the front of the column. Within this screw, but prevented from rotating with it, is a nut on which the elevating screw of the knee acts. Immediately on the completion of a cut, the partial rotation of the first mentioned coarse pitch screw, under the influence of the cam, thus serves to depress the elevating screw and with it the knee and the work, raising it again to its former position

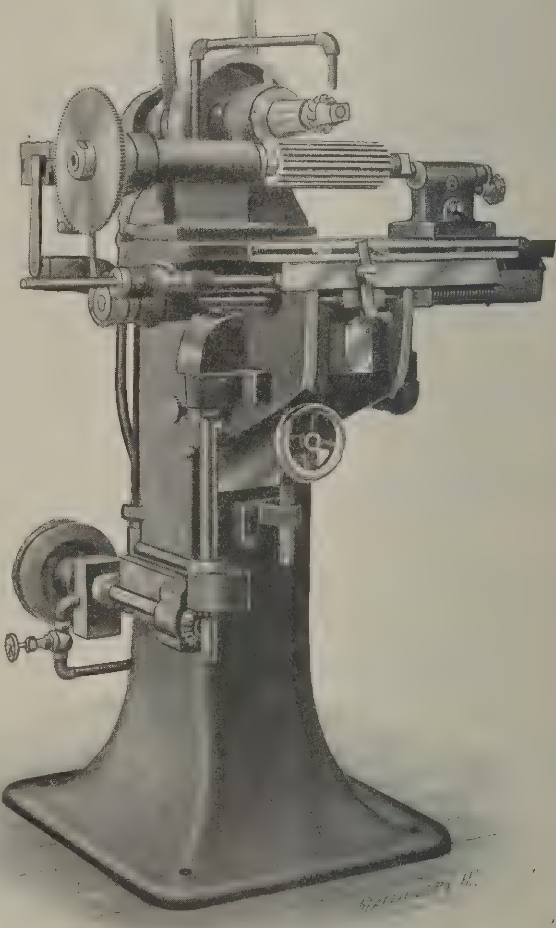


Fig. 2. Sloan & Chace Automatic Gear Cutter.

as the upper cam again commences to feed the work forward toward the cutter. A continuation of the bevel gear-driven shaft, which through the worm gearing rotates this cam shaft, operates the indexing mechanism, motion being conveyed to the change gearing at the right-hand end by a telescopic shaft with universal joints and a friction slip device. A trip on the vertical cam shaft releases the index gearing at the proper time when it is rotated through a complete revolution by the friction drive. An adjustable stop at the back of the work table, not shown in the cut, releases the shipper lever whose handle is seen projecting at the right, and stops the machine after any desired number of teeth. The countershaft used has a spring return and is held in engagement by the locking of this lever at its lowest position. The whole mechanism is thus arrested as soon as the last two have been cut with the work dropped away from the cutter and brought outward to the full extent of the return stroke.

The gear cutter shown in Fig. 2 shows plain evidences of the watch machine makers' ideas in its design, but it is intended to show the watch machine makers' ideas in the accuracy of its workmanship as well. The column is practically the same as that of the machine just shown. It is of the same general milling machine design. The cutter, of which a comparatively coarse pitch is shown in the cut, is mounted on an arbor in a rugged prolongation of the main spindle. The work is held between centers and is indexed by a notched

disk, as is usual in precision machine practice. The various movements, other than the cutting feed, are obtained from the pulley shown near the base of the column at the left-hand side. From here the motion is transmitted to the knee by means plainly visible. A feed screw is used in this case instead of a cam employed in the rack cutter shown in Fig. 1. The quick return of the feed motion is effected by the connections just described, while the forward feed is driven by a three-speed change gear box on the other side of the machine. The three feeds obtainable are approximately 0.010, 0.017 and 0.030 per revolution of the spindle. With the four-pitch cutter shown in place in the machine, without the slightest signs of distress in machine, cutter or work, 6½ inches per minute have been obtained in cast iron, 2⅛ inches per minute in machine steel, and 7¾ inches per minute in bronze. The travel of the table is determined by stops fastened in a T-slot at the front acting on a clutch lever which throws in, in turn, the feed and the quick return. A rather ingenious indexing mechanism, which entirely avoids the use of spring action in the withdrawal of the locking pin and the indexing of the work, rotates the blank the proper amount on the first half turn of the feed screw at the commencement of the feeding movement. A one-revolution clutch has been provided for this motion which has been specially designed to be operative even when the parts are rotated by hand at a very much slower rate than would occur when the machine is power driven. All the gears in the knee and the change gear box are of steel.

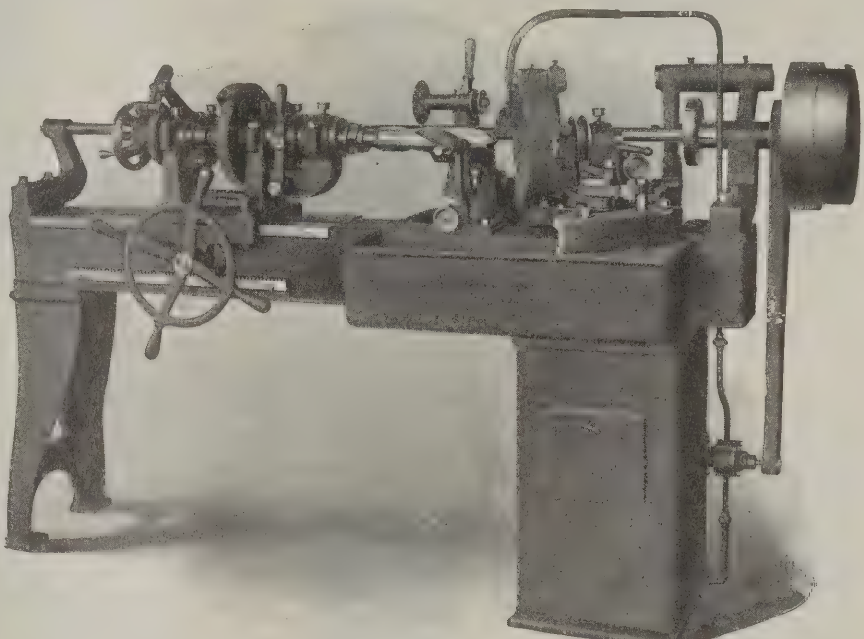
The head is adjustable in and out of the bed for centering the cutter. It has a three-step cone for a 2-inch belt, and gives speeds of 121, 217 and 312 revolutions per minute to the cutter. In both the spindle and the work arbor the usual No. 10 Brown & Sharpe taper is provided. For cutting steel the work table is provided with a pan lip, and an oil pump is arranged to be driven by the quick movement shaft at the lower left-hand side of the column; the reservoir for oil is inside of the frame. The makers call this their No. 3 automatic gear cutter.

THE DAHL AUTOMATIC DRILL GRINDER.

A glance at the accompanying halftone shows that this drill grinder is decidedly different from the type to which we have become accustomed in the last ten or fifteen years. There is, in fact, almost no element in this mechanism corresponding in any particular to that of the usual machine. The drill is placed in the chuck of this machine, brought up to the wheel, and the machine is started, after which it continues to grind the end of the lips to the proper contour until the dull portion has been removed when the operator, who has not meanwhile touched the machine, throws off the power and removes the drill.

A shaft at the rear extending the whole length of the bed and driven by the two-step cone at the right, furnishes the power for all the movements, excepting the rotation of the emery wheel itself. The wheel is of the cup type, grinding on its face, and is mounted on an independent spindle driven by a round belt from the countershaft. On flat ways on the left end of the bed is mounted a carriage provided with a quick traverse movement through the pilot wheel shown. This carriage carries the work-holding spindle, which is provided with a tapered hole and suitable collets for holding the drill in the same way it is held in the drill press. The spur gear shown in this spindle meshes with a pinion of half its diameter on the driving shaft in the rear, so that for every revolution of the spindle, which rotates continuously, the driving shaft makes two revolutions. After the work has been once set, the carriage is clamped in place by the handle shown at the right of the pilot wheel. The feed of the drill toward the wheel, as the grinding progresses, is accomplished by the mechanism shown at the rear of the carriage or an extension of the drill holding spindle. An eccentric on the rear driving shaft, acting on the feed screw, through the levers and ratchet wheel plainly shown, advances the drill a little at a time as each lip passes the face of the wheel. A slotted link in the connection between the eccentric and the ratchet wheel allows a variation in feed to suit the size of the drill and the amount of stock to be removed. As will be seen later, it is necessary that the cutting edge of the drill should preserve a constant angular position in relation to the driving shaft at the rear. To preserve this relation, use is made of the gage pin shown in the V-block support in which the outer end of the drill rests. With the back shaft in a definite position, the clutch is loosened by the operating lever seen between the right hand and the central bearings of the work spindle, and the drill is rotated until its cutting lip is properly located with reference to the gage just mentioned. The clutch is then thrown in again, when the drill and the other mechanism of the machine are fixed in proper relation to each other.

The wheel itself, driven from the countershaft by a round belt as before described, is mounted in a headstock which is free to swing about a vertical axis passing through the center line of the drill and its spindle, near the point of the drill. The cam shown on the back shaft just at the left of the right-hand bearing next to the pulley, through a system of levers,



Machine for Automatic Sharpening of Twist Drills.

imparts to the headstock and the wheel mounted in it a vibratory motion about its vertical axis, performing two complete cycles for each revolution of the drill by virtue of the fact that the driving shaft and work spindle are geared in the ratio of 2 to 1, as before described.

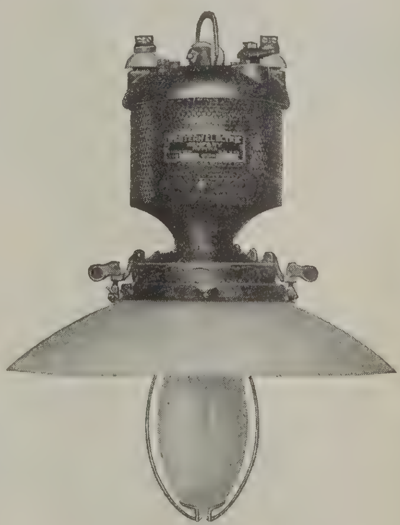
The action of the machine will now be readily apparent. The drill, rotating continuously and fed forward slowly, is pressed against the face of the revolving wheel which, being set at the proper angle for the cutting edge, is swung around to a gradually increasing angle as the heel of the drill is presented, thus giving to the tool its proper clearance. As the second cutting edge approaches, the cam swings the wheel back out of the way until the lip reaches the proper point for presentation to the wheel which, as before, swings in toward it again following the curve around to the heel. The drill, meanwhile, is advanced a slight amount by the feeding mechanism between the grinding of each lip.

A number of interesting points will be noticed in the mechanism. Provision is made, for instance, to insure an even wear across the whole face of the grinding wheel. At the front of the pivoted carriage on which the wheel is mounted will be seen a ratchet wheel adapted to engage with a stationary dog on the bed. As the wheel support is vibrated under the influence of the cam, this ratchet wheel passes toward and away from the dog in turn, receiving by this action a step by step rotating movement. To this ratchet

wheel is attached a crankpin and a connecting rod, which is, in turn, pivoted to a stud in the headstock casting, which carries the wheel. This headstock is not one piece with the pivoted carriage which forms its base, but is fastened to it through sliding ways. The gradual rotating of the ratchet wheel through the medium of the connecting rod gives to the wheel a slow reciprocating movement which continually presents to the work a new portion of the grinding face, over which the wear is thus evenly distributed. Messrs. Manning, Maxwell & Moore, Inc., 85-87-89 Liberty St., New York, who have placed this machine on the market, make the following claims: An unskilled operator can grind a drill at a true angle without difficulty; the adjustments for taking care of drills of different sizes from ½ to 3½ inches in diameter, are rapid and simple; the design of the machine insures equal height and even cutting on the lips of the drill; the wear on the face of the emery wheel is uniform. Suitable gages are provided for adjusting the wheel to make allowance for wear. A separately-driven small wheel is provided for thinning the points of the drill. This operation is performed without removing the drill from the machine. The wheel for this is shown in the position it occupies when not in use, at the rear of the drill being sharpened. The machine weighs approximately 1,900 pounds and is furnished regularly with one large emery wheel, one small wheel, and bushings for tapered shanks. Each machine is furnished complete with countershaft and necessary wrenches.

THE WESTERN ELECTRIC CO. SHORT ARC LAMP.

To meet the demand for a line of arc lamps to use in places where head room is scant, the Western Electric Co. of Chicago have designed the lamp shown in the accompanying cut. They believe that they have attained a more graceful and pleasing form, a more compact arrangement, and a better light distribution than have been reached by other manufacturers who have attempted a solution of the same problem. The over-all length has been reduced to the minimum obtainable, it being but 20 inches from the top of the lamp to the lower end of the inclosing globe; and this has been done without reducing the length of the carbon enough to materially cut down its life below that obtained in the ordinary five-ampere lamp. A life of 100 hours with each trimming is guaranteed. Instead of the large bulky case ordinarily found in short lamps, the use of indestructible windings and specially designed resistance units has resulted in very small dimensions and a design quite as symmetrical as that of the standard type manufactured by the company. In the choice of material for the different parts, only such have been used as have been found adapted for rooms where considerable heat is liable to be met with. The lamps are expected to be used in low cellars, engine rooms, boiler rooms, etc., so that this precaution is a necessary one.

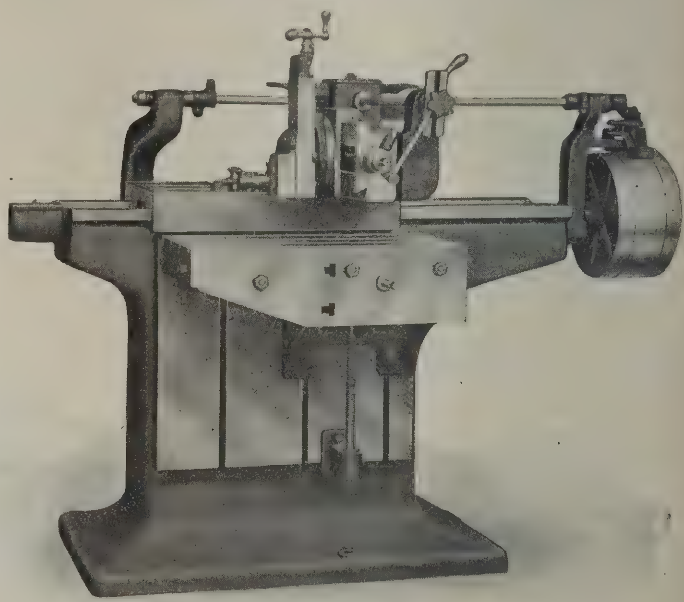


An Arc Lamp for low Ceilings.

It is found quite difficult in practice to apply any effective safeguard against injury by the use of fuses in lamps of this kind as ordinarily constructed, and it is not infrequently found that elements, which were thought to have been provided against, have wrought serious damage. In the new lamp provision is made to preserve it from injury even where fuses are omitted. The lamp may, in fact, remain with the arc entirely short circuited for hours without material injury; after which it will be found ready for normal operation the moment proper conditions are restored. This lamp may be obtained for use on 110-volt or 222-volt circuits, direct current.

THE CINCINNATI OPEN SIDE SHAPER OR PLANER.

The shaper of the "Richards" or "open side" type has so many advantages over the usual type for some kinds of work, that it seems strange that it has not come into more common use. Among other good points the design possesses, is the property of not making a "fan tail" cut; that is to say, the aggregate of the deflections of the members of the machine is constant throughout the stroke. It is not constant, of course, between the first stroke and the last stroke, but since most shaper cuts are longer than they are wide, the tendency of this condition is toward greater accuracy. On this machine also there is practically no limit to the diameter of shaft which can be key-seated. In the ordinary shaper usefulness in this direction is limited by the size of the opening through the column under the ram. The Richards shaper can be used on castings which are entirely beyond the range of the ordinary tools, for taking cuts of certain kinds; in fact, it may be said to have the advantages of the open side planer in this respect without its disadvantage of requiring the moving of the work back and forth.



Richards or Open Side Shaper, Built by the Cincinnati Shaper Co.

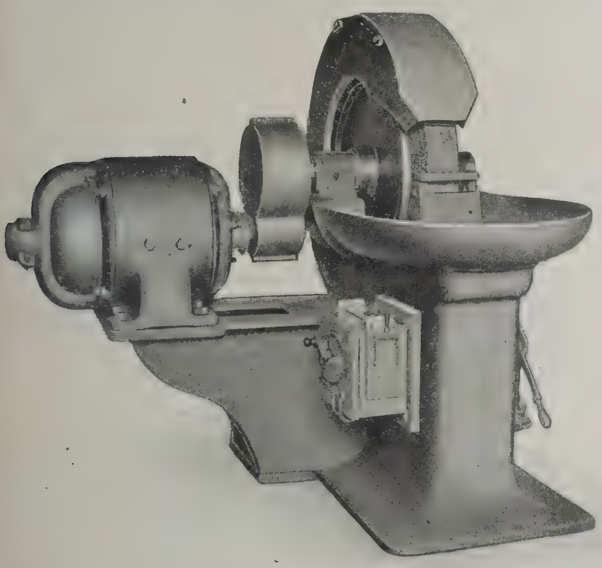
The machine here shown is the smallest of the line recently designed by the builders. It planes an area of 15 inches wide and 30 inches long. The ram is driven by a single screw and bronze nut without the intervention of any gears, this screw being 2⅛ inches in diameter and made of 0.50 carbon steel. The saddle has a long and wide bearing on the column with a narrow and deep guiding surface to prevent binding, particularly when the tool is at the outer end of the rail. A taper gib, adjustable longitudinally by means of screws at each end, is used to take up the wear uniformly throughout the length of the slide. The reversing mechanism, which is of the planer type, is operated by a means original with the builders. The rod extending across the rear of the machine is provided with stops adjustable longitudinally to vary the length and position of the stroke; two projecting wing-like cams at the rear of the slide are adapted to engage these stops; this engagement rotates the stop rod slightly in one direction or the other, depending on which direction the slide is traveling. There is no longitudinal movement of the stop rod, and it is supported on ball bearings for the rotating movement. The feed motion is derived from this partial rotation of the shifting mechanism. The adjustable feed crank is geared with the stop rod and partakes of this motion, giving it in turn to a ratchet feed of the usual construction at the end of the feed screw on the cross rail. The head has a down feed of 6½ inches. The swivel is graduated and is provided with a micrometer collar reading to 0.001 inch. The table is raised and lowered by means of a crank handle, not shown, and is provided with a supplementary table at one side, as may be seen from the cut. This supplementary table may be removed so that the work may be bolted against the side of the table proper, or the whole table may be removed, when pieces may

be fastened directly to the column. All flat bearings are hand scraped to surface plates, and all T-slots are cut from the solid.

The size shown, 15 x 30 inches, has a net weight for the machine and countershaft of 3,450 pounds. The ratio of cut to return is 1 to 2. The length of the table with the extension is 30 inches, and it has a width of 18 inches and a depth of 12 inches. The Cincinnati Shaper Co., Garrard Ave. and Elam St., Cincinnati, Ohio, are the builders.

THE BRIDGEPORT GEARED MOTOR DRIVEN TOOL GRINDER.

The Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn., have placed on the market the geared motor driven wet tool grinder shown in the cut below. As may be seen, the motor is mounted on a shelf cast to the base of the machine, and is connected to the wheel spindle through gearing in the ratio of 3 to 1. This arrangement runs very quietly; the gears are carefully cut, are encased to exclude dust and grit, and the bearings are self-oiling. The machine can be started up when the power starts in the morning and run as long as the shop does if desired, avoiding the need for starting and stopping the machine each time it is used. Any motor required by the customer can be fitted to this machine. The No. 5 size here shown takes a 5 horsepower motor. The bearings are 8 inches in length. The emery wheel used is

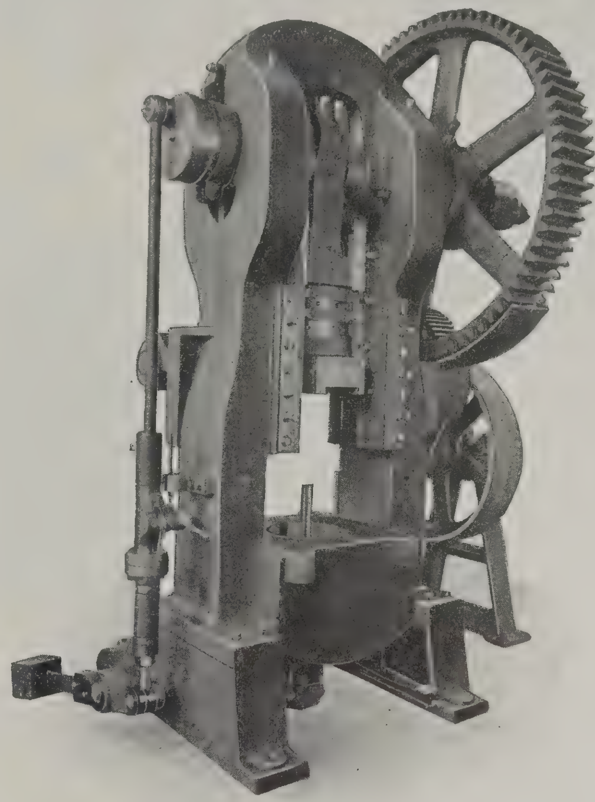


A Geared Motor-driven Tool Grinder.

36 inches in diameter with a 4-inch face, and the machine occupies a floor space of 30 x 47 inches. The wheel runs at 425 revolutions per minute. The weight of the machine with the motor is 2,650 pounds.

A LARGE SINGLE CRANK PRESS.

The E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y., have recently completed the largest single crank press ever built in their shops. The constant demand for increased size in the product of power presses has necessitated a constant growth in their dimensions. The press we show is one that would a few years ago have seemed of abnormal size—beyond the capabilities of the makers to build or the purchaser to use. It is now, however, simply an unusually large machine of a well-known type, with the addition of certain improvements in detail which adapt it more nearly to the work it has to do. The machine is double geared, with an automatic jaw clutch on the crank shaft as in smaller presses. This clutch is positive in its action, and is silent whether in operation or not. The ratio of the gearing is 25 to 1, and the entire train is made from steel castings with the teeth cut from the solid. The large gear is 80 inches in diameter by 10 inches face and weighs 4,500 pounds. The arrangement is such that the gearing will not interfere with the operator in work that requires his attendance at the rear of the press. The knockout, which is plainly shown, is operated from a crank at the left-hand end of the crankshaft. It is adjustable for length by means of the stop screw and lock nut in the projecting bracket at the lower left-hand side of the frame; this operates a releasing mechanism in the knockout connecting rod and limits the upward movement, which is thus adjustable to any point



Bliss Single Crank Press of Unusual Size.

required. Through a crank and rock shaft the knockout motion is carried to the vertical plunger in the center of the bed, where it is applied to the parts provided for removing the work from the die. The crank operating the knockout is held to the shaft by a ratchet disk, which allows it to be shifted in any angular position to suit the requirements of the work being done. This adjustment is in addition to the variable stroke obtained by the releasing mechanism just described. The slide has an unusually long bearing in the frame and is scraped to it; the pressure strain comes against solid metal rather than against the gibs which are provided to take up the wear. A vertical adjustment of 3 inches in the slide is obtained by a screw 18½ inches in diameter. This screw is made with a flat thread on the pressure side, thus preventing all side strains.

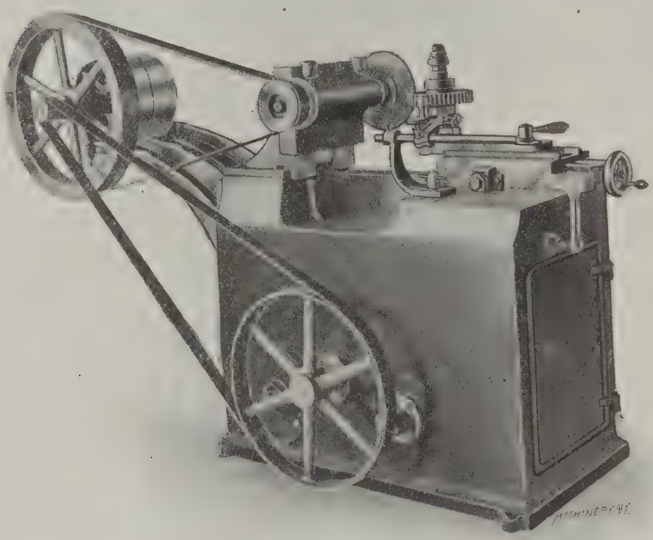
An idea of the size of this press may be had from the following facts: The frame is a solid casting and weighs over 18,500 pounds. The area of the bed is 31 inches by 32 inches. The distance from the bed to the slide with the work and adjustment up is 30 inches. The shaft is 9 inches in diameter and has a 12-inch stroke. The flywheel is 50 inches in diameter by 10 inches face and weighs 2,500 pounds, making 250 revolutions per minute. The total height of the press is 12 feet 9 inches, and the total weight is something over 41,000 pounds.

A FINISHING GRINDER FOR CAST GEAR TEETH.

The machine which we illustrate herewith is for a somewhat unusual purpose. Immense quantities of cast gearing are used in agricultural and textile machine and other products of that kind, a field in which the cut gear has as yet made little impression. Cast teeth are on the whole made more accurately and smoothly than ever before, but it is still necessary to resort to the file and cold chisel very often in preparing the gear castings for service, as fins and lumps are liable to occur on the tooth faces of even the best work of this kind. To perform this operation automatically Messrs. Upton & Gil-

man, of Lowell, Mass., have devised the automatic gear grinding machine here shown.

The gear blank is mounted on a vertical arbor in a slide on top of the bed. The grinder wheel is presented to the work on a horizontal axis held in a vertical reciprocating slide whose travel may be adjusted from 0 to 5 inches. A quick return crank motion is provided for this. While the grinding wheel is returning to commence a new stroke, the mechanism within the base of the machine withdraws the work, indexes it, and again presents it to have a new tooth smoothed off.



Machine for Smoothing the Teeth of Cast Gears.

The working parts are all so far as possible carried inside of the base, where they are protected from the grit of the emery wheel. The capacity of the machine is for spur gears from 4 to 36 inches in diameter and up to 4 inches in face. Its weight is about 2,200 pounds. The original machine has been successfully run in one of the largest shops in Lowell for several years and has proved its usefulness and durability. To this shop the makers will be pleased to refer inquiry.

A HEAVY NEWTON SLAB MILLER.

With the considerable increase in the size of machinery of various descriptions, especially in the case of locomotives, on which there is a great deal of forging and other steel work; with the growth of the modern practice of forging roughly and depending on the finishing process to bring the forging to shape and in condition to use; and with the demand for the greater strength and stiffness required by high speed steels, the weight, power and rigidity of the heavier machine tools such as slab milling machines, for instance, has been increased to a remarkable degree. The miller shown in the accompanying cuts, built by the Newton Machine Tool Works, Inc., Philadelphia, Pa., reflects very plainly the influence of the considerations just enumerated. In fact, the builders believe that they have successfully discounted the severest conditions likely to be met with in service.

The spindle of the machine shown is 6½ inches in diameter and has a main bearing 15 inches long; it is driven by a phosphor bronze worm wheel and a casehardened worm of steep lead, provided with a roller thrust bearing, and is positively geared to a 35 horsepower 2 to 1 variable speed motor. The driving worm and worm wheel have a ratio of 20 to 1. The spindle has an 8-inch adjustment lengthwise (that is to say, across the table of the machine) for convenience in setting the cutters after the work has been located on the platen. To permit this the spindle is driven from the worm wheel by a double spline. The arbor is driven by a "butterfly" key, it being provided with a tongue on the face of its collar which engages the groove milled across the front end of the spindle. The outboard bearing for the arbor is bushed; the bushing is tapered on the outside and split to allow adjustment for wear. It is arranged to fit over the arbor bushings and to be adjusted to support the arbor close up to the work. The cross rail on which the main and outboard spindle bearings are attached has an inclined face bringing the bearing surface normal to the resultant pressure caused by the rotation of the cutter and the feeding of the work. This does away with the tendency of the tool to pull in or gouge into the work.

The main upright has a bearing surface 25 inches wide while the outboard bearing has a face 12 inches wide; the length of the bearing of the cross rail on these two uprights is respectively 38 inches and 31 inches. This gives some idea of the ample proportions followed in designing the machine. The cross rail is counterweighted, has hand adjustment with quick power movement in both directions, and its power movement is so designed as to be available for sinking the cutter to the required depth by power. The makers believe that this is a new feature. To permit this the elevating screws are arranged to pull the cross rail down into the work instead of pushing it as in other designs, this arrangement overcoming the tendency of the cross rail to rise. Besides being a great time saver, this feature overcomes the chief difficulty previously experienced in fluting locomotive connecting rods, where it is necessary to sink the cutter to a depth of from 1½ to 1¾ inch in the rod. In connection with this a provision is made to prevent the table from pulling forward when sinking in, thus overcoming the breaking of cutters and arbors and the consequent damage which results from this cause and from the upward spring of the cross rail. The fact that the center of the spindle is 4 inches below the lower edge of the cross rail makes the machine convenient in working around oil cup bosses on locomotive connecting rods, and in sinking in and milling keyways on shafts of large diameters having collars and projections of considerable size. The table, which is gibbed to the outside of the bed, is driven from the motor through positive gearing entirely. The feed provided gives from 1 to 10 inches per minute with quick power movement in either direction, obtained through a compact gear box easy to control and more rigid in construction than any that has yet been designed for this work. Sliding gears are used,

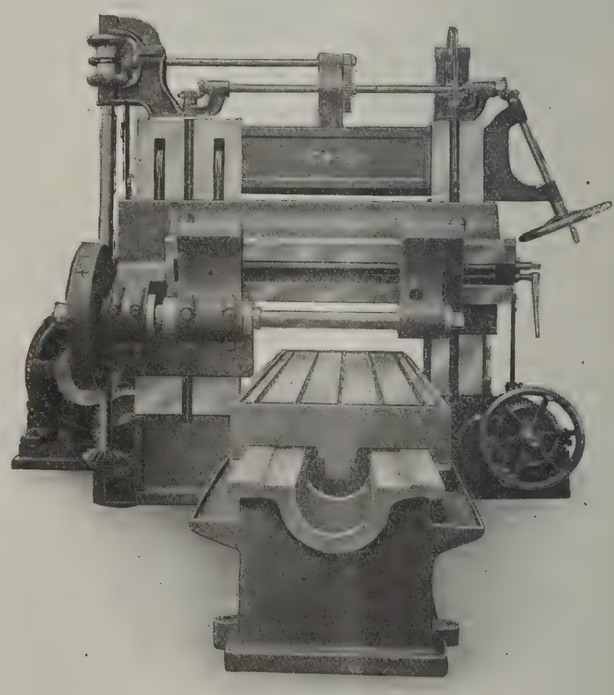


Fig. 1. Front View of Newton Slab Miller.

the contact edges of the teeth being beveled so that the change can be readily made while the machine is running. From this gear box motion is transmitted to a bronze spiral pinion on an angular shaft meshing with a steel rack 4 inches wide on the under side of the platen. The gears in the gear box are all of steel and run in oil.

In actual service for something over six months, the time maintained for two different jobs (of which large quantities have been performed) are as follows: In a milling cut with a width of 9½ inches and a depth of cut of 9/16 inch a linear feed of the platen has been maintained at 8 inches per min-

ute, giving a removal in chips equal to 43 cubic inches per minute, or about 1¼ cubic inch per minute of rated horsepower. The makers believe that this extraordinary record is in part due to the rigidity and weight of the machine, and in part to the worm drive. The Newton Machine Tool Works have been using the worm drive for many years, and to them is due a large share of the credit for the change of opinion which has lately taken place in favor of this method of transmitting power. In fluting or channeling locomotive connect-

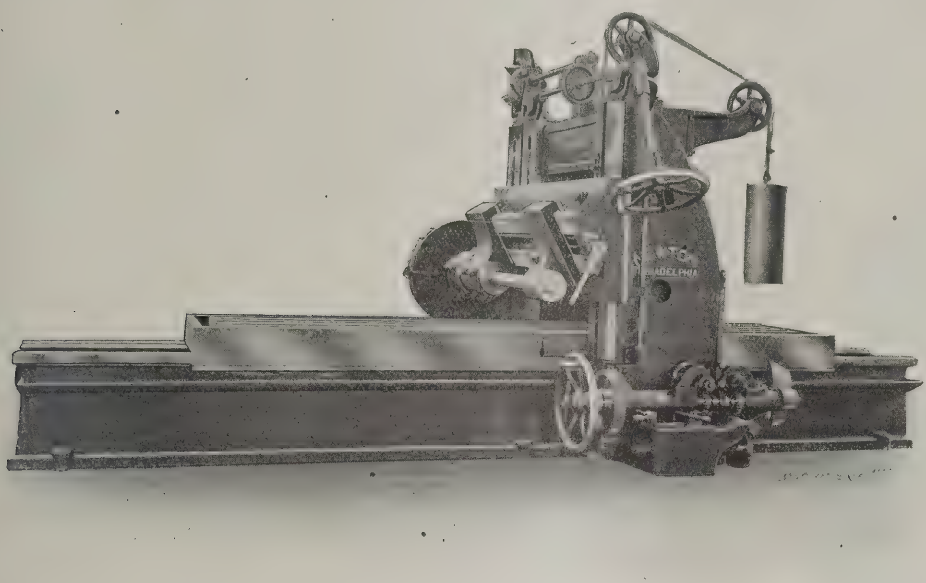


Fig. 2. Side View of Newton Slab Miller, showing Feed Mechanism.

ing rods, doing two at a time, a cut is taken 3 inches wide and 1½ inch deep, the feed of which is 3¼ per minute, this making a section of 9 square inches being removed at the feed just given. The figures given above have been maintained on this work for some time past. The cutter used is of the inserted tooth type, the teeth being of air-hardened steel inserted on a true helix. The cutting speed is about 86 feet per minute at the periphery of the cutter.

ALTENEDER'S DRAFTSMEN'S PEN-FILLING INK STAND.

Since the discarding of the old-fashioned process of grinding India ink as fast as it is used, the troublesome question has arisen of where to put the ink bottle so that it may be safe from overturn and still be convenient. To provide a bottle holder that will be both safe and convenient, and in addition to that, to provide a means for filling the draftsman's pen very much more quickly and easily than it can otherwise be done, Theo. Alteneder & Sons, of Philadelphia, have devised the ink stand shown in Figs. 1 and 2.

Fig. 1. The Alteneder Pen Filler and Ink Stand.

The first of the two halftones gives an idea of the construction of the device. The cast-iron base is sufficiently heavy to supply the element of stability, an element whose need is strongly felt when working with a bottle unprovided with a holder. This base is designed to receive and securely hold the standard bottle now in general use. The forked spring shown surrounds the neck of the bottle and holds its base firmly within the recess provided for it. Pivoted to the frame at the rear end of the device is a lever with a rest for the palm of the hand at one end, and a stopper and pen filler at the other. The stopper is a disk of soft rubber, held down over the mouth of the bottle by the weight of the lever to which it is attached. Experiment has shown that this arrangement is as efficient in preventing evaporation as is the cork now in use. The pen filler or "dipper" consists of a coiled spring fastened at the end of a stem projecting down from the end of the lever through the rubber cap. Three or four of the lower coils of this spring are pulled away and bent slightly to the rear of the upper portion, while the lowermost loop is turned at right angles to its normal position, in a way which cannot be easily described, but which works beautifully in actual use. This little arrangement is adapted to picking up and holding a sufficient amount of ink for one filling of the pen, this ink being immediately released when contact is made between the lower loop of the spring and inside of the nibs of the pen.

In inserting a bottle in this holder, first remove and discard the stopper and quill which come with it. With the right hand placed on the rest, raise the dipper and hold it at the limit of its upward movement, then with the left hand insert the bottle in the recess under the spring. If, after the bottle has been inserted, it is found to be so much shorter than the average that the dipper touches the bottom and holds the rubber cap away from the mouth, shift the cap to a lower groove on the dipper stem. Three of these grooves will be

Fig. 2. The Pen Filler in Use.

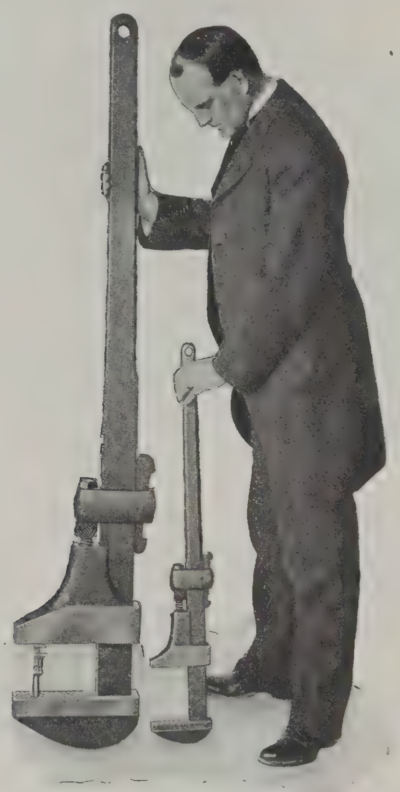
found. This should also be done when the dipper is found to be picking up sediment. In using the ink stand, place it on the drawing board within easy reach, slightly to the right and with the name-plate end nearest the body, as shown in Fig. 2. With the point held precisely as when ruling a line, place the hand on the rest, depressing it and holding it firmly at the limit of its movement; then bring the point directly under the dipper. Raise the point until the dipper loop has entered between the blades, and move the hand slowly so that the loop will just touch the blades, when the pen will fill instantly. Without trying to draw the loop through the blades, lower the pen, move it one side and take the hand from the rest, when the cap will descend and close the bottle. The entire operation consumes less than five seconds.

The advantages claimed for the device are: a saving of time in filling the pen; a certainty in the amount of ink delivered each time the filler is used; safety and convenience in holding the ink bottle of standard form; provision of an automatic stopper; efficiency in preventing evaporation; and the

avoidance of the necessity of using more than one hand in filling the pen, leaving the other one free to hold the T-square, triangle, or other instrument being used.

THE LARGEST SCREW WRENCH YET MADE.

One would scarcely expect that any practical use would be found for an adjustable screw wrench of as great size as the largest one shown in the cut below, yet there has been a sufficient demand for a tool of this magnitude to induce the Coes Wrench Co. of Worcester, Mass., to undertake its manufacture. The wrench is of their T-model pattern, which provides a quick adjustment to two or three different positions, after which the final tightening is accomplished by a nut in the usual manner. This wrench is 72 inches in length. An idea



Three Members of the Coes Family of Screw Wrenches.

of its great size is obtained in comparing it, on the one hand, with the stature of Mr. Coes who holds it, and on the other hand with the smallest size wrench of the Coes line, which it held between its jaws. This series of key wrenches is made from steel forgings and steel castings throughout, all the parts being hardened.

The use to which this tool is put is in the tightening of the large nuts used in bridge construction. It was built in response to inquiries from bridge-building companies, and it was concluded, from the nature of the inquiries, that a tool of this size would be required to meet extreme conditions. The wrench has a full jaw opening of 12 inches with a depth of 8 inches. The jaw weighs 33½ pounds, the screw weighs 8½ pounds, the bar 114 pounds, and the total weight is 160 pounds. The complete line now includes 28-inch, 36-inch, 48-inch and 72-inch sizes. The 36-inch size, shown also in the cut, has been found especially useful for opening hopper-bottom cars, and many have been sold for that purpose.

* * *

Water-proof glue is manufactured of gum shellac, three parts and India-rubber, one part by weight, these constituents being dissolved in separate vessels in ether, free from alcohol, subject to a gentle heat. When thoroughly dissolved, the two solutions are mixed, and kept for some time in a vessel tightly sealed. This glue resists the action of water, both hot and cold, as well as most acids and alkalis. If the glue is thinned by the admixture of ether, and applied as a varnish to leather along the seams where this has been sewn together, it renders the joint or seam water-tight, and almost impossible to separate.—*Scientific American.*

EUROPEAN INDUSTRIAL NOTES.

PRESENT CONDITION OF BRITISH MACHINE BUSINESS.

It is perhaps superfluous to state that, speaking generally, business over here in the engineering and tool-building lines is booming. At the same time it cannot be said there is any particular symptom of feverish "hustling." People are, so far as the available supply of competent men allows, working their plants as many hours as they think pay, and extending their equipment as current deliveries of tools and considerations of prudence permit. After doing this they cease worrying, knowing everyone else is too busy to do them much harm. Looking back, say about six or eight years, it is interesting to note how the jeremiades then more or less current as a result of loose journalistic generalizations have been falsified. Far from foreign competition extinguishing any really staple industry, most have only been revitalized as a consequence of investigation into weak spots thus caused. It is almost safe to say the lessons the United States then had to teach have been taken to heart with comparatively little whining, and so gradually utilized that shop practice has, almost unconsciously, undergone a virtual revolution.

In the tool trade, the Taylor-White steel demonstration at Paris in 1900 found the British makers at some advantage over the Americans, as most of their (the British) tools had more "weft" in them than the American ones, though less handy in some particulars. Following up this fortuitous circumstance, they have easily kept pace with the advances in high-speed steel, and have seldom been confronted by really serious competition in the heavier branches. At the same time, the undoubted merits of the best class of American tools have met, and still meet with, the heartiest recognition on the part of British users, as shown by the fact that deliveries of this class of machinery are spoken for, in some cases, eighteen months ahead. Incidentally, it may be stated that any first-class American tools which by any means come to auction or forced sale, are as eagerly picked up as though new, but much of the rubbish sent over here at the time of the cycle boom is now to be found in marine store dealers' establishments, drifting toward the scrap heap.

The system of confining productive energies to a comparatively limited variety of machinery has made rapid advances, coincidently with the fact of several American concerns broadening out in the direction of greater variety. Even where strict specialization is not—probably for good reasons—over-favorably viewed, tools are produced in larger batches at a time than formerly, thus allowing a greater net profit or productivity than might perhaps be expected. Further, travel in the States and on the Continent of Europe on the part of works proprietors, managers, business men, and, to a greater extent than perhaps imagined, workmen, has tended to rapid assimilation of cosmopolitan methods, a process assisted to a not inconsiderable extent by the spread of technical education in various forms. On this side, some of the old-established concerns hold a very strong position as regards the supplying of heavy tools for ordnance purposes, and this position has been further strengthened since the building of large steam turbines called for tools of extremely wide range. Then, again, the automobile industry, which is advancing in a remarkable manner, has enormously stimulated the demand for high-class tools of medium and light weight, in addition to encouraging cognate industries in the way of driving chains, roller and ball bearings, milling cutter manufacture, gear-cutting specialization, etc. Concurrently with these developments, gas engines of large power—utilizing blast-furnace and producer gas—are being built in increasing numbers, and the manufacture of electrical plants of most classes is now firmly established in this country, another circumstance explaining the present condition of affairs in the tool shops. An interesting sequence of these developments is the diminution of output of former types of "merchant" tools which were built with low first cost as the sole motive of production. Users of every degree of familiarity with tool practice are so well posted comparatively that selection of plant is now accorded more intelligent consideration, and the demands the toolmaker has to meet become correspondingly more exacting. A noticeable feature at the moment is the

tendency of manufacturing industries to leave the neighborhood of London for localities where land, rates, taxes, and labor are cheaper, and the increasing alertness of local governing bodies in the matter of encouragement of such migration. A movement is also afoot, in the form of "Garden Cities" associations, to create industrial communities in which manufactures may be carried on with a minimum of objectionable features, and the maximum of healthful and pleasant living and social conditions. Another form of industrial association, originated in this country, touches the cotton industry directly, and thus, practically every other industry. The organization alluded to is the "British Cotton Growing Association," formed, as a consequenece of the last attempts to "corner" American cotton, for the purpose of encouraging the growth of cotton, primarily in the British empire, and secondly in other portions of the two hemispheres. This beginning has led to combined action of all the European cotton-using countries to enlarge the sources of supply of the raw material, and thus circumvent and minimize the activity of parasitical cotton speculators. This association is supported by employers, work people, and government colonial departments, and can point to very definite results already. It is a rather ironical fact that a committee of the association is about to visit the United States with a view to formulating a report on the possibilities of the improvement of cotton growing, harvesting, packing and shipment. It may be news to many that American cotton is packed and shipped in the most slovenly and wasteful manner of any in the world. Egypt and India are miles ahead in this matter.

The immediately preceding remarks may appear to have little bearing on the machinists' and toolmakers' business, but, more probably than any other class, are the people interested in these branches of work influenced, favorably or otherwise, according as the raw materials of industry are, or are not, available in sufficient quantity at the right price and right time. In a further letter I hope to give some details of British activity in toolmaking and engineering generally.

Manchester, Eng., November 23, 1906. JAMES VOSE.

THE AUTOMOBILE INDUSTRY OF ITALY IN 1906.

The automobile industry in Italy, though dating only from five years ago, continues to develop and increase in importance so rapidly that it is recognized and valued as one of the larger industries of Italy. Great strides have also been made in the mechanical arts, especially in the manufacture of machine tools. Official statistics of the automobile industry in Italy are as yet few, but it is very instructive to note some returns published lately by the eminent engineer, Prof. Effen Magrini.

From these may be seen that previous to the year 1905 there were only nine manufacturers of automobiles in all Italy, with a total effective capital of about 85,000,000 francs (17,000,000). During the year 1905 this number was increased by twenty-five with a capital of 45,000,000 francs ($9,000,000), and in the first six months of 1906 seventeen more companies were founded with an effective capital of about 100,000,000 francs ($20,000,000).

Over and above this must be counted the carriage manufactories, which in July, 1906, numbered 19 with a capital of about 24,000,000 francs ($4,800,000), and the other industries connected with automobiles, such as the manufactories of chassis, lamps, lubricators, tires, brakes, etc., the garages for testing and repairing, amounting to 30 firms, with a capital of about 24,000,000 francs ($4,800,000).

Examining the number and value of the automobiles imported and exported in the last five years, we find that from 1900 till 1903 the imports were 1,070, with a value of 8,402,548 francs ($1,680,510); in 1904 the imports were 410, with a value of 4,110,860 francs ($822,172); and in 1905 the number imported was 667, with a value of 6,239,000 francs ($1,247,800). For the present year, 1906, it may be safely assumed that the figures will be: 1,200 automobiles imported, corresponding to the sum of 12,000,000 francs ($2,400,000).

With regard to the automobiles exported, the figures are: From 1900 to 1903, 98, with a value of 894,750 francs ($178,950); in 1904, 127, value 1,112,560 francs ($222,512); in 1905, 287, value 3,646,000 francs ($729,200); and this year the number exported will be about 462, with a value of 6,450,000 francs ($1,290,000).

After France, the United States does the largest trade with Italy in the automobile business; in the year 1904, for example, of 410 automobiles imported in Italy, 304 were from France, 48 from the United States, 43 from Germany, and 15 from other European countries. Of 126 exported, 70 were sent to France, 24 to the United States, 15 to Austria-Hungary, 7 to South America, and the remainder to other parts of Europe, Asia and Africa. Perhaps we may account for active business relations between Italy and the United States in this branch of industry by the great demand in the Italian market for American machine tools. I. E. T.

Milan, Italy, December 1, 1906.

MISCELLANEOUS FOREIGN NOTES.

HIGH-TENSION CONDUCTORS.—At the Milan exhibition experiments were undertaken with insulated cables manufactured by Pirelli & Co., Milan. These cables were tested to breakdown, which occurred at voltages varying from 208,000 to 210,000 volts. Pirelli & Co. claim to be the first makers of cables for commercial use intended to withstand such high pressures.

THE MACHINE TOOL TRADE BUSY AND PROSPEROUS IN GERMANY.—According to *Zeitschrift fur Werkzeugmaschinen und Werkzeuge*, the German machine tool builders are very busy at the present time and the business is in a prosperous state. In many places it has been necessary to work overtime even during the summer months, although this has sometimes met with objections on the part of the men. Wages have increased from 10 to 25 per cent, due mainly to the increasing difficulty of securing skilled help.

THE ALLGEMEINE ELEKTRICITÄTS-GESELLSCHAFT, with works at various places in Germany, reports for the year ending June 30, 1906, a growing business. The total capital has been increased by $3,500,000 to $25,000,000, on which, for the past year, a dividend of 11 per cent is proposed. The output of machines, electromotors and transformers was numerically greater by 34 per cent than in the previous year, the increase reckoned in kilowatts was 26 per cent, and in value the receipts were greater by about 20 per cent. The total number of the employes was 33,906, as compared with 30,366 in the previous year.

WEBSTER & BENNETT, LTD., Coventry, England, have recently brought out a two spindle high speed drilling machine intended for drilling holes with small center distance. The machine is designed for obtaining the maximum work from ½ inch to 1½ inch high-speed drills. The minimum center distance between the spindles is 4 inches, and the maximum distance 18 inches. The maximum distance between the spindle and the table is 24 inches. The spindles are fitted with a No. 4 Morse taper. The table is of the usual form for this class of machines with T-slots on the top as well as on the vertical front face. The table is 24 inches square, and the height of the vertical face is 20 inches. The two spindles are independent as to drive and feed.

JOHN LANG & SONS, Johnstone, N. B., have brought out a 36-inch facing and boring lathe fitted with their patent variable speed drive and automatic speed changing mechanism. With these in operation, when facing work, such as cylinder covers, faceplates, etc., the revolutions of the spindle automatically increase as the diameter being turned becomes smaller. The hexagon turret is fitted for carrying ordinary or special tool holders. The self-acting feed motions are positive and four different feeds may be had without stopping the lathe. When specially ordered eight feeds may be provided which can be thrown in without interrupting the work on hand. The standard feeds per revolutions of spindle are 1/4, 1/8, 1/12 and 1/16 inch. The approximate floor space required is 12 x 5½ feet.

IMITATION OF DAMASCUS GUN BARRELS BY BELGIAN MANUFACTURERS.—According to a report from Consul J. C. McNally, Damascus gun barrels are imitated so closely by Belgian manufacturers that the imitation is very difficult to detect. The manufacturers in practicing this deception use silk paper, and by

means of a decalcomania transfer, this design is attached to the plain barrel by the use of certain acids and processes which are kept secret. It is almost impossible for any one not thoroughly familiar with the manufacture of these guns to distinguish between the real and the imitated Damascus barrel. In order to make a test it is necessary to erase the design. If an imitation, the design cannot be restored, but if the Damascus is genuine the application of sulphuric acid will immediately bring out the original design. According to the consular report 200,000 barrels are annually manufactured with this imitated design. Most of them are sent to the United States and to South America. Double-barrel shot guns are usually the only kind thus imitated.

American Machine Tools in Great Britain.—Consul Albert Halstead, of Birmingham, advises that the market for standard American machine tools gained in the United Kingdom and the Continent through their superior excellence, is threatened, chiefly because of the inability of American manufacturers to make reasonably early deliveries. Because of the present long delays in filling orders for American machine tools, British manufacturers are, to a large extent, buying tools that can be delivered immediately. British tool makers, who have heretofore pushed their own designs, noting the inability of American machine tool makers to fill orders promptly, as well as the financial success of several British firms in copying American tools, are now spurred on to make tools on American models. The delay in the delivery of any reputable American lathes and milling machines averages now from three to six months. Until quite recently these tools were kept in stock and a delay of six weeks was unusual. The delivery of universal milling machines is now made in from six to nine months and gear-cutting machinery often cannot be obtained under twelve months. When they cannot be assured of getting standard American machine tools promptly, British and other foreign manufacturers buy those they can secure as soon as ordered. If such substitute tools work well, they will naturally order similar tools when they require more, which means permanently lost trade for the American tool builder. Every machine tool-making industry in the United Kingdom is reported to be overhauling its patterns and bringing them up to date; in short, the British tool makers are Americanizing their tools.

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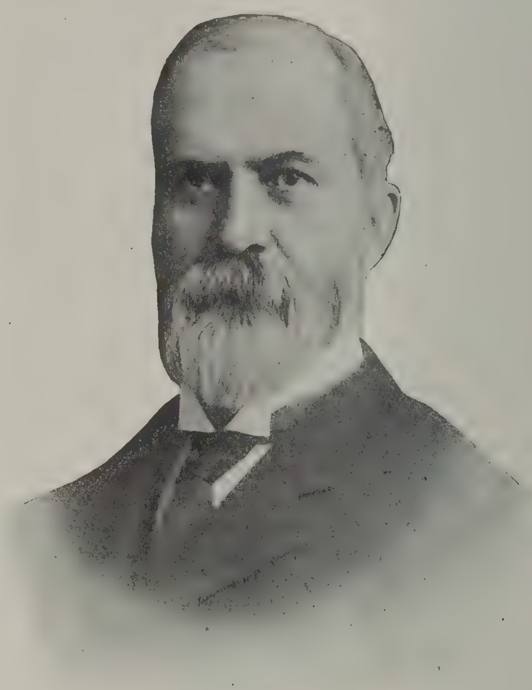
OBITUARY.

Henry J. Hendey, president of the Hendey Machine Co., Torrington, Conn., died at his home in that town December 8 after an illness of several weeks with a complication of diseases, principal of which was nervous exhaustion. Mr. Hendey was born in London, England, December 29, 1844. He came to this country with his father in 1858, and located at Waterbury, where he learned the machinist's trade. In 1865 he went to Torrington (then Wolcottville) and entered the employ of the Turner & Seymour Co. as a machinist. In 1870 Mr. Hendey in company with his brother Arthur started in business for himself in a small machine shop on Litchfield Street. The motive power of the shop was a small rotary steam engine of three horsepower which had been built by Mr. Hendey for amusement. The engine has been carefully kept and is now to be seen in the power plant of the Hendey Machine Co. alongside of the 500-horsepower Harris-Corliss compound engine driving the present shop. At first the business of the brothers in the original 18 x 24-foot shop was principally repairing machinery, but they soon began building planers and other machine tools, and in a few months the work had increased so that they employed one man and a boy. In 1871 the brothers removed to part of a factory known as the East Branch spoon shop, and later, in 1874, the Hendey Machine Co. was organized with a capital stock of $16,000. A factory was built on the present site near the Coe Brass Works. The growth of the business of the company has been rapid, both in the United States and abroad; the Hendey-Norton lathes are favorably known wherever machine tools are used. The shops are modern, up-to-date structures, with electric drive throughout, and about 600 men are now employed. In the early part of their career the company built planers, but the planer business is now discontinued, and the product is confined to lathes, shapers and milling machines, the milling machine having been added to the product a few years ago. The present capital stock of the company is $300,000. Mr. Hendey had been president of the Hendey Machine Co. since 1883.

Mr. Hendey was prominent in the local affairs of Torrington; he was the first warden of the borough and afterward served as burgess. Later he was elected a member of the State Legislature, where he was made one of the committee of manufactures. For many years he had been a senior warden of Trinity Church, and he was a past master of Seneca Lodge,



Henry J. Hendey.

No. 55, F. & A. M. Until only recently he took an active part in the local affairs, and always stood for those things which helped to make the community stronger and better. His way of looking at public matters was broad and just. The struggles of his early life developed within him a vigorous habit of thought and action, but no inclination toward anything except absolute justice. Mr. Hendey was a great lover of his home and found there the principal source of the joy of living.

Arthur R. Jones, superintendent of the American & British Mfg. Co., Bridgeport, Conn., died suddenly October 11 after a few hours illness. Mr. Jones was about forty years old and was born in Willimantic, Conn.

Henry C. Clark, president of the Clark Bros. Bolt Co. and the Aetna Nut Co., Southington, Conn., died December 4 of pneumonia at the age of 78. Mr. Clark was one of the pioneers in the bolt and nut business.

Wallace J. Johnson, for the last twenty years with the Niagara Falls Hydraulic Power & Mfg. Co., died at Niagara Falls, December 15, at the age of 50 years. He was born in Granville, Mass., and was a well known civil and hydraulic engineer.

Edward Payson Bullard, Sr., president of the Bullard Machine Tool Co., died suddenly December 22 at Braidentown, Florida. He left Bridgeport December 19 in apparent normal health for his regular Southern trip. A biographical article on Mr. Bullard will be published in a later issue.

B. H. Warren died of apoplexy October 20, in New York City. He was at one time vice-president of the Westinghouse Electric and Manufacturing Co., and later president of the Allis-Chalmers Co. Upon his retirement from the latter company he entered into consulting work in company with Messrs. Kafer and Mattice in New York.

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PERSONAL.

Frank H. Taylor has been elected vice-president of the Yale & Towne Mfg. Co. Mr. Taylor was formerly vice-president of

the Westinghouse Electric & Mfg. Co. and is still a director of that company.

Henry G. Judd, for five years secretary and superintendent of the Mattatuck Mfg. Co., Waterbury, Conn., has resigned to become superintendent of the Noera Mfg. Co., of the same place.

On January 1 Mr. H. H. Lane, who has been editor of *The Foundry*, since October, 1903, will sever his connection with the Penton Publishing Company to engage in the practice of consulting foundry engineering with headquarters in Cleveland. Mr. Lane also expects to have New York connections, and will be in a position to advise on all classes of foundry construction and foundry metallurgy, including gray iron, steel and malleable. He will continue his position as secretary of the Foundry Supply Association for the present, and devote a much larger amount of his time to the work of the association than would be possible under the former management. This will redound to the success of the convention of the American Foundrymen's Association in Philadelphia, May 20 to 24 next. Mr. A. O. Backert, formerly Pittsburg editor of *The Iron Trade Review* and later western editor of *The Iron Age*, with headquarters in Chicago, will succeed Mr. Lane as editor of *The Foundry*. Mr. Backert has had a wide acquaintance among foundrymen, and was prominent in the work of the Pittsburg Foundrymen's Association for several years.

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THE VALUE OF HAVING A FIRM NAME WELL-KNOWN.

In these days of advertising generally by concerns in all sorts of businesses, one is occasionally found which conservatively holds to the old idea that the best kind of an advertisement is a satisfied customer. While this idea is true enough, it has the fault of not being the whole truth. The satisfied customer does not usually go about the country drumming up business for the firm which filled his orders, although he may recommend it, perhaps, whenever occasion seems fit. Parenthetically we might remark, however, that a satisfied customer is usually quite willing that any competitor shall remain very much in the dark about the source of his machinery or other equipment if it can be conveniently concealed, and so far as "blowing a horn" for the builders of such he is more likely to discourage all inquiries. We speak from knowledge in view of our experience oftentimes in trying to get the names of builders of special machinery. As regards advertising it is worth much for any concern to get its name so well established that it can scarcely be quoted incorrectly. Bearing on this point, we recently published a short article describing a piece of engineering work done by a concern which claims to believe that doctors, lawyers and engineering concerns should follow about the same code of ethics, *i. e.*, depend upon the drumming for business done by their friends. Unfortunately and very much to our own vexation the name of this concern was given incorrectly. That it was given incorrectly is not so surprising, for we are unable to find in any publication coming into this office an advertisement containing the name of the concern in question although it is a fairly well-known institution in a restricted field. The point to be made is that while we were not by any means entirely dependent upon memory for the correct name we depended upon it in the absence of more convenient reference and this proved to be faulty, and the same mistake might have happened with a prospective customer. That this slip could have happened with one of many other engineering concerns which have followed a liberal policy in the matter of advertising is scarcely possible. How such desirable publicity shall be obtained is a matter that has to be decided individually.

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FRESH FROM THE PRESS.

Proceedings of the 14th Annual Convention of the National Railroad Master Blacksmiths' Association. 203 pages, 5½ x 8½ inches. Illustrated. Edited by A. L. Woodworth (Secretary N. R. M. B. A.), Lima, Ohio.

This is a report of the proceedings of the 14th annual convention held at Chicago, Ill., August, 1906.

Ready Reference Tables and Price List for Railway Car Men. Pamphlet 6 x 9 inches. Published by McConway & Torley Co., Pittsburg, Pa.

The pamphlet is a compilation of tables beginning with a list of M. C. B. couplers giving weights and prices; then follow parts of freight cars; wheels and axles; cost of helical springs at 3½ cents per pound; cost of cast iron at 1¾ cent per pound, etc.

Historic Locomotives. By Alfred R. Bennett. 36 pages, 9¾ x 13½ inches. 10 full-page plates. Published by Castle & Co., Ltd., London, England, and Derry-Collard Co., New York. Price, $1.00.

The book describes and illustrates the Great Western Railway Co.'s broad-gage engine "Great Western"; London & South-Western Railway Company's four-coupled engine "Milo"; London, Brighton & South Coast Railway engine No. 122; Caledonian Railway 8-foot single driving wheel engine No. 83; Bristol & Exeter Railway Co.'s 9-foot driving wheel broad-gage engine No. 42; North British Railway engine No. 224; London, Brighton & South Coast engine No. 111; London & North-Western Railway engine "Prince of Wales" No. 291; outside cylinder Crampton locomotives and inside cylinder Crampton locomotives, South-Eastern Railway. The plates are gorgeously colored, the like of which we are inclined to say "was never seen on land or sea," but the author assures us that the colorings are faithful reproductions of the originals. As a picture book it will undoubtedly attract considerable attention, but to the practical railroader it has little interest.

Switchboards. By William Baxter, Jr. 192 pages, 5½ x 7½ inches. 150 illustrations. Published by the Derry-Collard Co., New York. Price, $1.50.

The importance of the switchboard in any electrical plant is so obvious that it is unnecessary to dwell upon it. The book in review is intended to be a practical description of the instruments, their method of connection and location; the things to be avoided; how to connect machines; how to balance on the three-wire system; connecting in parallel; and the many other features connected with the switchboard which have to do with the operation of a power plant. The work is profusely illustrated with drawings and half-tones and is written by one who by many years of practical and theoretical experience is well qualified to write a book of this character. His writings have the characteristics of lucidity of style and clearness of meaning which make them very popular with the class of readers to whom this book will appeal.

Practical Metal Turning. By Joseph G. Horner. 404 pages, 5½ x 8 inches. Illustrated with 488 cuts. Published by Norman W. Henley & Son, New York. Price, $3.50.

This work is the same as Engineers' Turning, reviewed in this column in October, 1905. It is intended to be a compendium treating in a comprehensive manner on the modern practice of machining metal parts in the lathe, including the engine lathe, its tools, attachments, manner of holding the work and performing the operations. It is decidedly British in its tone, as would naturally be inferred from the authorship, and the fact that the work was originally published in Great Britain by Crosby Lockwood & Son, London; Norman W. Henley & Son, New York, have brought out an American edition, believing that it will meet with favor among a considerable number. It is a work of value containing as it does much practical instruction and many good shop kinks for apprentices and journeymen machinists. The style is clear and simple; the book is gotten up in substantial style, well printed and well bound.

Walschaerts Locomotive Valve Gear. By W. W. Wood. 193 pages, 5 x 7 inches. Illustrated with 36 cuts and diagrams with two separate cardboard models of valves in pocket of book. Published by Norman W. Henley & Son, New York. Price, $1.50.

The book is composed of four general divisions, the first of which explains and analyzes the Walschaerts valve gear; the second takes up designing and erection; the third has to do with the actual work of the Walschaerts gear; and the fourth section is composed of questions and answers in the popular catechism style. The wide interest at the present time in the Walschaerts valve gear, due to its introduction in American locomotive construction, makes the appearance of this book timely, and it should meet the wants of a considerable class of railroad men who are looking for a practical work on the subject. The folding diagrams with cardboard valve models, by which the actual operation of the valve under the influence of the Walschaerts motion can be studied, is a novel and interesting feature.

Tools for Machinists and Woodworkers. By Joseph G. Horner. 340 pages, 5¼ x 7¾ inches. 406 figures. Published by Norman W. Henley & Son, New York. Price, $3.50.

The object of this book is to comprise a general description and classification of cutting tools, together with modern instruments of measuring. It takes up tool angles, and gives considerable space to the conditions affecting the cutting action of woodworking tools, including knives, chisels, planes, etc. Then follow scraping tools, tools related to both chisels and scrapers, percussion and molding tools, hardening, tempering, grinding and sharpening tools for measurement and testing, etc. Mr. Horner is a well-known English writer on technical subjects; he has done an enormous amount of this kind of work for various English technical publications and in books of his own. The work is gotten up in attractive style and will no doubt interest a large class of amateur readers who desire information on the fundamental principles of cutting tools. Mixed in with it all there is a great deal of information of value to the journeyman machinist, carpenter and other tradesmen having to do with the use of cutting tools and tools of precision.

Practical Lettering. By Thomas F. Meinhardt. 16 pages, 9 x 14 inches, bound in paper. Published by Norman W. Henley & Son, New York. Price, 60 cents.

Ths work describes an original system for spacing which results in a superior appearance of lettering, especially when of the block type. Probably all draftsmen have noticed that uniform spacing between block letters does not give a good appearance. For example, the letters H I N in the word "WASHINGTON" will be too close together with a uniform system. Meinhardt's system gives variation in spacing for Gothic style or any variety of plain letters without shade. The height of the letter is divided into 16 parts, and one of these parts is taken as the unit of spacing, the chart giving the number of units to be used between any combination of letters. For example in the word WASHINGTON, instead of using a space between H and I corresponding to the width of the main stem of the I, as would naturally follow with the ordinary system of spacing, the space is made four units or twice the width of the stem. The work is one well worth the attention of those interested in ornamental and practical lettering.

Punches, Dies and Tools for Manufacturing in Presses. By Joseph V. Woodworth. 483 pages, 6 x 9 inches. 702 illustrations. Published by Norman W. Henley & Son, New York. Price, $4.00.

This work is gotten up in the same style as Mr. Woodworth's former book on dies—"Dies, Their Construction and Use, etc."—and is intended to be a companion and reference volume to accompany same. This book devotes much attention to sub-press work which is coming to be of more and more importance as improved methods of manufacturing such machines as typewriters, computers and similar products are developed. The sub-press principle makes each combination of punch and die a unit which may be brought into use at any time without the need of an expert to set up the press. Its general use tends to greatly simplify press working. A large part of the work has already appeared in the columns of the trade papers, having been contributed by various writers. The work is therefore largely one of compilation, aided by the author's expert knowledge on the subject. The book is timely and is one that should be appreciated by diemakers and others interested in modern methods of interchangeable manufacture of machine parts.

CONTENTS FOR JANUARY.

Engineering in the United States. By Frank Foster. 115 pages, 5¾ x 9 inches. Published by the University Press, Manchester, England.

This book is essentially a report made by Mr. Foster, who was a Gartside Scholar of the University of Manchester. Gartside scholarships were established in 1902, being open to certain university students to enable them to travel abroad and study existing industrial conditions in Germany Switzerland and the United States. This work is an account of Mr. Foster's experience in the United States and is a very readable and interesting work, although few Americans will read it and agree with all that Mr. Foster has said. It strikes one who is well acquainted with American conditions that some of Mr. Foster's observations are superficial and in some cases have illustrated what we presume is the traditional British lack of humor, especially when he dilates on the relations of superintendents and their men. However, the work as a whole gives evidence of very careful and systematic investigations of our industrial conditions. The writer not only visited many shops but worked in many as an ordinary workman for wages without favor, hence he was "up against the real thing."

Modern American Machine Tools. By Prof. C. H. Benjamin, 320 pages, 5½ x 9 inches. 134 illustrations. Published by Archibald Constable & Co., London.

This work was compiled by Prof. Benjamin, of the Case School of Applied Science, Cleveland, Ohio, at the instance of the London publishers, for the purpose of conveniently acquainting Europeans with the general characteristics of the American machine tools. It is consequently gotten up with this in mind and is a sort of amplified catalogue giving features of the various American lathes, planers, radial and upright drills, shapers boring mills, milling machines, gear cutters, grinding machines, key-seaters, punching and shearing machinery, etc., with brief descriptions derived from the author's knowledge and various catalogues, together with what has been published in the technical press. The work is gotten up in fairly good style considering the difficulties of such a work. A compilation of this sort should be of much value to a considerable class, not only abroad but here as well, who are desirous of being posted on the general characteristics of various machine tools and to obtain the matter in convenient form for reference. We should expect that its use in certain engineering schools will follow, where it is desired to give the students an idea of the scope and importance of the modern American machine tool.

The leading feature in the January issue of the *Century* is Mr. Roosevelt's latest essay, "The Ancient Irish Sagas." Other contributors of noteworthy papers are Cardinal Gibbons and Prof. Henry Fairfield Osborne. The serial story, "The Shuttle," by Miss Burnett, is continued, and the issue abounds with numerous short stories and fine art features.

NEW TRADE LITERATURE.

Fulton Machine and Vise Co., Lowville, N. Y. Catalogue of the Reed universal, vertical and horizontal swivel vise. The jaws and both swivels are clamped with one operation of the lever.

The New Era Mfg. Co., Kalamazoo, Mich. Booklet, "All About Babbitt Metals," containing valuable information for superintendents and master mechanics on the subject of babbitt metals.

The Car Interchange Manual, published by McConway & Torley Co., Pittsburg, Pa., and which was reviewed in the December issue, is sent free on request to those interested. We mentioned the price of 25 cents, but the distribution is free.

Ingersoll-Rand Co., 11 Broadway, New York. Form X 36 entitled Rand "Imperial," Type 10, Air Compressors giving a detailed description of the more important parts of the compressor and containing many half-tone and sectional drawings of the machine.

T. R. Almond Mfg. Co., 83 Washington Street, Brooklyn, N. Y. Pamphlet describing Almond adjustable electric lamp fixtures, and telling of some of their varied uses. These fixtures are flexible, being constructed in a way similar to the well known Almond flexible tubing.

Joseph Dixon Crucible Co., Jersey City, N. J., have published a booklet calling attention to the advantages of Dixon's Ticonderoga flake graphite as a cylinder lubricant for air compressors. Those who are interested in air compressors or drills should obtain a copy.

The Mark Flather Planer Co., Nashua, N. H. Bulletin No. 7 on Flather planers describing and illustrating the different types. The first page contains a general description of their product, detailed specifications of which will be submitted upon request.

E. W. Bliss Co., 5 Adams Street, Brooklyn, N. Y., 1906 catalogue describing and illustrating the various dies, presses and special machinery built by this company. It contains 578 pages, among which is included an alphabetical index of the subject matter.

Geo. V. Cresson Co., Philadelphia, Pa., have issued catalogue B for 1906 on power transmitting machinery. It is a cloth-bound book containing 349 pages, including many useful tables and illustrated by excellent engravings. A complete index of the contents is given in back of book.

The Abrasive Material Co., Philadelphia, Pa. Illustrated catalogue for 1907 of emery and corundum wheels. Descriptions of the product together with price lists are given. The materials used by this company are constantly being tested and thus a high standard of efficiency is maintained.

The Hisey-Wolf Machine Co., Cincinnati, Ohio., have redesigned their line of portable electrical hand drills and have succeeded in reducing the weight of them considerably. This is a very desirable feature in portable tools, as the lighter they are the less they will tire the user in handling them. The company now have in press a new catalogue of their newly designed portable electrically driven drills.

The Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn. New catalogue for 1907 treating of emery wheels and grinding machinery. The book calls attention to the changes which have been made in their former line of grinding machinery and illustrates other lines recently brought out. A new line of edge and surface grinders is being brought out which is not shown in this issue. Those interested may obtain blueprints and prices upon request.

Heinrich Dreyer, Berlin, Germany. Catalogue (in German) of machine tools and appliances, principally American. This handsomely illustrated catalogue lists and describes Bullard boring mills, Hendey-Norton milling machines, Whitcomb-Blaisdell lathes, Newton milling machines, Cincinnati tool grinders, Morse grinding machines, Garvin vertical milling machines, Hartford automatic screw machines, etc., and several other American machine tools; some foreign machines are also included.

The Reeves Pulley Co., Columbus, Indiana, have sent us an impressive list of the large metal working concerns using the Reeves variable speed transmission. These names include The Western Electric Co., Chicago, Ill.; American Tool Works Co., Cincinnati, Ohio; American Car & Foundry Co., Detroit, Mich.; Atlas Engine Works, Indianapolis, Ind.; G. A. Gray Co., Cincinnati, Ohio; Niles Tool Works Co., Hamilton, Ohio; Westinghouse Electric & Mfg. Co., Pittsburg, Pa., and many others.

The New Process Raw Hide Co., Syracuse N. Y. Catalogue of raw hide pinions giving a hint of the difference between the "New Process" and other raw hide gears. The catalogue contains a price list of pinions from 2 inches to 15 inches outside diameter and 1 inch to 10 inches face. It also contains a partial list of prominent users of the "New Process" pinions. The catalogue is sent out in a strong manila "wallet" which will be found convenient for carrying papers in the pocket, for which it was designed.

Gisholt Machine Co., Madison, Wis. Catalogue of the Gisholt universal tool grinder, and Gisholt lathes and boring mills. This handsomely gotten up piece of advertising literature is principally devoted to the Gisholt grinder illustrating the loss of time and productive effort which follows the old method of each individual machine operator grinding his own tools. It contains a reduced view of the chart which accompanies each Gisholt grinder, showing the correct angles for grinding lathe tools, and other matters of interest to machine shop managers.

MANUFACTURERS' NOTES.

The Wm. W. Gang Co., Cincinnati, Ohio, are making extensions and improvements in their factory which will give them about 3,500 square feet additional floor space.

The Hisey-Wolf Machine Co., Cincinnati O., advise that they have received from Washington a diploma and honorable mention on their exhibit of portable electrical drills and grinders, at the Liege, Belgium exhibition.

The Queen City Punch and Shear Co. are now located at 208-212 Lawrence St., Cincinnati, O. and will soon be ready with a full line of punches, shears and straightening and bending machines. Mr. C. F. Mayer is president of the company and C. F. Heinss is secretary and treasurer.

The Mueller Machine Tool Co., 216 W. Pearl St., Cincinnati, Ohio, have been incorporated, and the company will erect a new and up-to-date machine shop at Colerain Avenue, near Draper Street, to accommodate their increasing business. It is expected that the new shop will be completed some time next spring.

The International Railway Master Boiler Makers' Association and the Master Steam Boiler Makers' Association meet in joint convention at Cleveland, Ohio, May 21, 22 and 23, 1907, to organize one grand body of foremen boiler makers. Further information may be obtained from the secretary of the latter association, Mr. J. H. Smyth, 284 Totowa Avenue Paterson, N. J.

J. H. Wagenhorst & Co., Youngstown, O., have recently made the following sales of blueprinting machines: Oklahoma City Railway Co., Oklahoma; Ohio State University, Columbus O.; G. D. Peters & Co., Moorgate Works, London, England; Griffin Wheel Co., Chicago, Ill.; Alvey-Ferguson Co., Louisville, Ky.; New England Structural Co., Boston, Mass.; Eugene Dietzgen Co., Chicago, Ill.; American Steam Pump Co., Battle Creek, Mich.

The Billings & Spencer Co., Hartford, Conn., have decided to open a Canadian branch for the manufacture of drop forgings and drop forging machinery. It will be known as the Canadian Billings & Spen-

RAILWAY MACHINERY.

A special edition of MACHINERY devoted to Locomotive and Car Equipment and Mechanics.

February, 1907.

THROUGH THE SIMPLON TUNNEL.

A. R. BELL.

The new trans-Alpine route between Switzerland and Italy effected by the completion of the Simplon Tunnel has been one of the most notable engineering triumphs of the country. This road forms the sixth railway route over the Alps. The first tunnel constructed was that between Austria and Styria in 1848 on the railway through the Semmering pass. This line forms the through route between Vienna and Venice. The Semmering tunnel is less than a mile in length, but long and severe grades have to be encountered on either side to reach it. The Mont Cenis followed next in 1861-1870, about 7¾ miles long. The expresses from Paris to Turin and Rome are the principal ones traversing it. Then came the Arlberg between Switzerland and the Tyrol, about 5 miles long. The Brenner route was opened in 1867, but has no very long tunnels. A great undertaking was completed in 1882 by the opening of the St. Gothard, 9¼ miles long, and which took 10 years to construct. The scenery on this route is the grandest of any, and several viaducts, galleries, and shorter tunnels had to be provided before the main one could be reached. Surpassing the St. Gothard in length by over three miles, the tunnel just completed through the Simplon will prove of immense benefit to the district of Italy, of which Milan is the chief city. It is over 12½ miles long and has occupied 6½ years in building.

Fig. 1. Freight Train Approaching the Simplon Tunnel.

Fig. 2. Paris-Milan Express with Steam Locomotive about to be Detached at Brigue.

Fig. 3. Paris-Milan Express at Brigue, with Electric Locomotive Attached and ready to Enter the Simplon Tunnel.

Fig. 4. Entrance to the Simplon Tunnel at Brigue.

The diligence road over the Simplon was constructed by order of Napoleon in 1805 mainly for military transport, but has been used during many years for tourist traffic. A magnificent triumphal arch in Milan commemorates the opening of the pass, and during the past year the opening of the tunnel has been appropriately acknowledged by the Milanese in a grand international exhibition.

The traffic through the Simplon tunnel is now entirely worked by electric power on the three-phase system, the current being derived from dynamos and turbines driven by water power. The power plants are situated at Brigue on the Swiss side and Iselle on the Italian. At these places the steam locomotives are detached and electric ones substituted.

The absence of the suffocating atmosphere met with in the St. Gothard and Mt. Cenis tunnels is very noticeable when going through the Simplon. The time taken to go through the tunnel is about 25 minutes.

The contract for constructing the tunnel was left to Brandt Brandau & Co. in 1898, and the start was made from both ends soon after. The estimated progress was at the rate of 32.35 feet per day, but the actual average advance was less than this. Early in 1901 considerable interruption was caused by an inrush of water from a spring. The cutting through was

completed in 1905 and the enlarging to necessary dimensions completed in six months. At present only one tunnel is finished, but the second one is partly made.

The entrance at Brigue is 2,250 feet above sea level, and that at Iselle 2,073 feet. The summit of the tunnel is almost exactly under the frontier line, and is 2,312 feet above sea level, with about 7,000 feet of solid mountain overhead. The gradient from the Swiss end is 1 in 500, and that from the Italian 1 in 143. There is a short level stretch near the middle. The extreme width of the completed tunnel is 16 feet, and the height 17 feet. Three thousand five hundred workmen were employed in its construction, and the estimate for cost was $13,490,000.

In the central station at Brigue there is one three-phase alternator rated at 1,200 horsepower at 160 revolutions per minute, but which is capable of supplying temporary overload up to 1,500 horsepower. It is driven from a main transmission shaft by two Escher-Wyss turbines, each of 600 horsepower; the fall is 146 feet. The alternator is excited from a 95 horsepower dynamo. An automatic regulator is provided to adjust the capacity of the water resistance in accordance with the load on the line, so that the alternator is always kept fully loaded and therefore no risk of any serious variation of speed. All the instruments and controlling apparatus are fixed on one board from which connections are made with the conductors and rails by means of overhead wires.

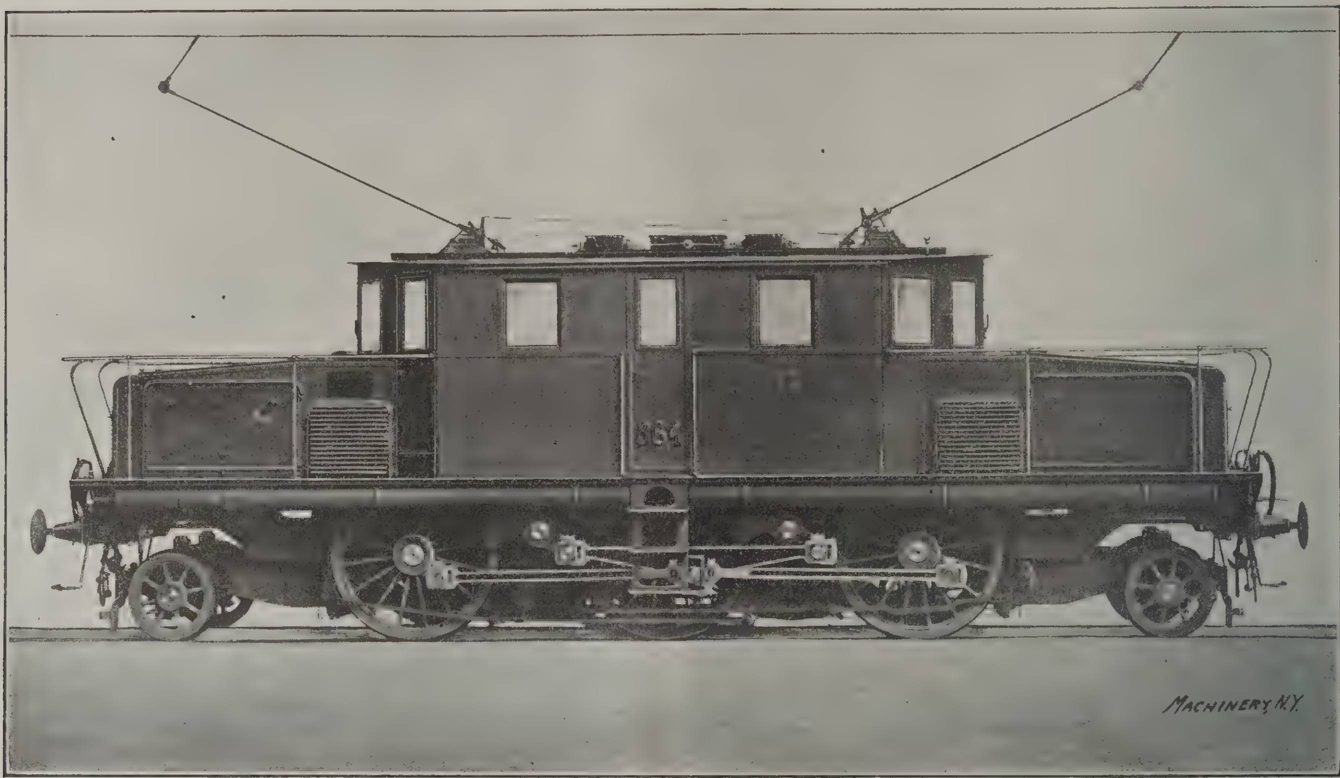


Fig. 1. Second Brown, Boveri & Co. Electric Locomotive in Use in the Simplon Tunnel.

Fig. 2. Ganz & Co. Electric Locomotive for the Simplon Tunnel.

At Iselle there is one three-phase alternator rated at 1,500 horsepower. It is direct coupled to a double-ended turbine from Picard & Pictet, of Geneva, each of the turbine units being capable of developing 750 horsepower. The set runs at 960 revolutions per minute with a fall of 460 feet, and is fitted with a sensitive governor which keeps the speed nearly con-

stant. This set can be overloaded up to 1,800 horsepower and even more. The excitation current is taken from a continuous current machine of 95 horsepower, and 125 volts, which was formerly used in the tunnelling operations.

The line is divided into five sections: 1. Brigue station to northern entrance to tunnel. 2. Northern half of tunnel. 3. Crossing in middle of tunnel. 4. Southern half of tunnel. 5. Southern end of tunnel to Iselle. Section switches are provided at Brigue, at Iselle, and in the middle of the tunnel. Telephonic communication enables the staff in charge to transmit orders.

The overhead line outside the tunnel is suspended on cross wires strained between steel poles placed on each side of the track. In the tunnel the conductors are carried on cross wires which go from one side to the other and are fixed by means of gun metal bolts cemented into the walls of the tunnel. The cross wires are fixed about 83 feet apart on the straight portions, and about 40 feet apart on the curves.

The rails themselves form the third conductor and have been bonded by a special system. The fish plates form the

Fig. 3. First Electric Locomotive for the Simplon Tunnel, built by Brown, Boveri & Co.

conductors. Perfect contact is insured by cleaning the joints with a sand blast and covering the contact faces with a special paste which prevents oxidation.

The locomotives are of the bogie type with five axles of which three are driven by motors. The motors are placed between the three pairs of driving wheels and both drive on the middle axle by means of a bar coupling them rigidly together. The axle in turn drives the other two by means of a coupling rod. The following are the leading dimensions of the locomotives:

Length between buffers............	40 feet 6 inches
Total length between axles..........	31 feet 10 inches
Distance between driving axles.....	16 feet 1 inch
Distance between bogies............	23 feet
Diameter of driving wheels........	5 feet 4½ inches
Diameter of smaller wheels........	2 feet 9½ inches
Weight on driving wheels..........	42 tons
Total weight......................	62 tons
Normal output of two motors.......	900 horsepower
Maximum output of two motors.....	2,300 horsepower
Normal speed..	42 miles per hour and 21 miles per hour
Drawbar pull at 42 m. p. h..	7,700 lbs. nor., 20,000 max.
Drawbar pull at 21 m. p. h..	13,500 lbs. nor., 31,000 max.

The traction motors are each rated at 450 horsepower and work with three-phase current at 2,700 to 3,000 volts. Their momentary overload capacity is as high as 1,150 horsepower per motor at the higher speed. At the lower speed they are rated at 390 horsepower, but can be overloaded continuously up to 575 horsepower.

THE SIMPLON TUNNEL ELECTRIC LOCOMOTIVE EQUIPMENT.

FRANK C. PERKINS.

The Simplon tunnel is about 12.5 miles in length and is the longest railway tunnel in the world. It was decided by the Swiss and Italian governments to operate trains through this great tunnel exclusively by means of electric power and the Swiss and Italian commissioners chose the three-phase high tension alternating current system as installed by Ganz & Co., of Budapest, Austria-Hungary.

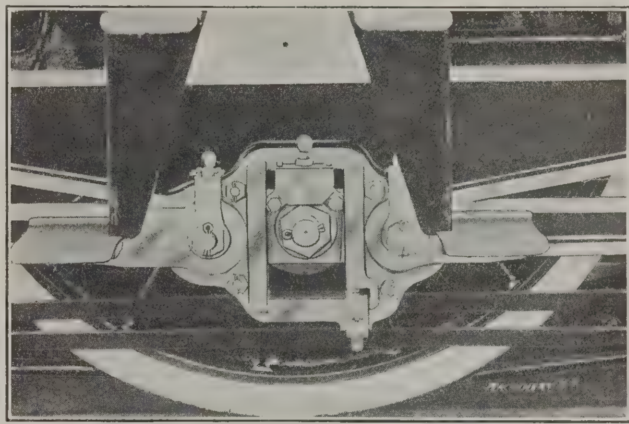


Fig. 4. Bearing of Connecting-rod and Side Rods on Middle Crankpin.

A most careful investigation was made of the various electric railway systems now in operation by the general director of the Federal railways, officials of the Swiss Post, as well as a special Italian and Swiss Commission for the study of electric traction, which included the well known engineers Thormann and Boveri, of Brown, Boveri & Co., of Baden, Switzerland.

After inspecting the electric lines and power stations in northern Italy, including the Morbegno hydro-electric plant, the Lierna transformer sub-station, the Valtellina railway and the Milan-Porto Ceresio electric line which uses the multiple unit system, with current supplied from the Tornavento power house and the Galarato sub-station, a decision was made.

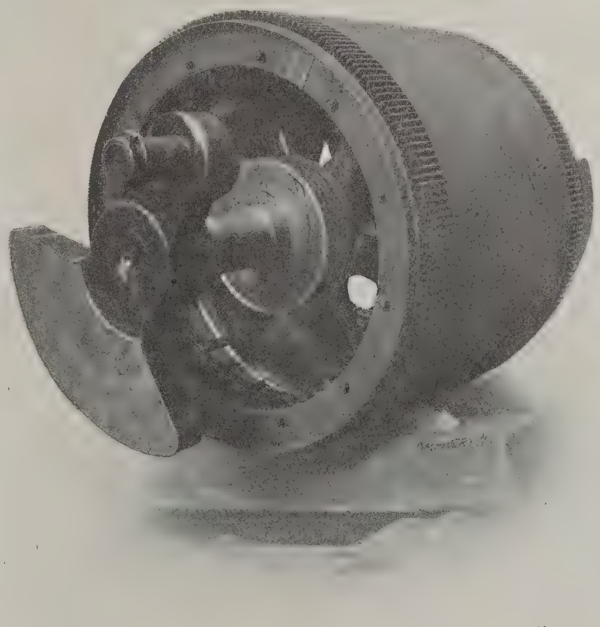


Fig. 5. Rotor of Brown, Boveri & Co. Electric Locomotive.

The accompanying illustrations show the construction of the Ganz & Co. Simplon Tunnel locomotive, also the first 1,000-horsepower Simplon locomotive No. 365, built at Baden, Switzerland, by Brown, Boveri & Co. and the Brown, Boveri Simplon locomotive completed at the time of the opening of the Simplon tunnel in 1906. The three-phase electric engine No. 365 is shown in end view; also the rotor of one of the motors, Fig. 5, is shown which develop normally 575 horsepower each with a maximum capacity of 1,150 horsepower. This gives a total maximum power of 2,300 horsepower for

this locomotive which is capable of hauling a heavy train of passenger cars through the tunnel at the rate of about 45 miles per hour. This latest type is 40 feet 5 inches long over the buffers and has a wheel-base of 16 feet for the driving axles and a total wheel-base measuring 31 feet 10 inches, while its weight is 124,000 pounds.

After a careful study of the details of construction of the new Ganz electric locomotives of the three-phase type, the motors and controlling apparatus as well as the track and overhead construction of the Valtellina railway, the sub-stations and power plant, it was considered best to adopt the

Fig. 6. Twin Motor of Ganz & Co. Locomotive.

three-phase system with a pressure of 3,000 volts and a frequency of 15 cycles per second. Trial runs were made for ascertaining the loads of the trains, the working of the electric locomotives on level track and while ascending and descending heavy grades. Tests were also made of starting and stopping heavy trains by this commission of 12 Swiss and Italian officials and electrical engineers.

There is every reason to believe that all of the steam railway lines in Northern Italy will soon be electrified, current being transmitted from hydro-electric stations in the Italian Alps. Electric locomotives have been decided upon as most satisfactory for the Simplon tunnel service on account of the ease of transfer of trains to and from steam-driven railway

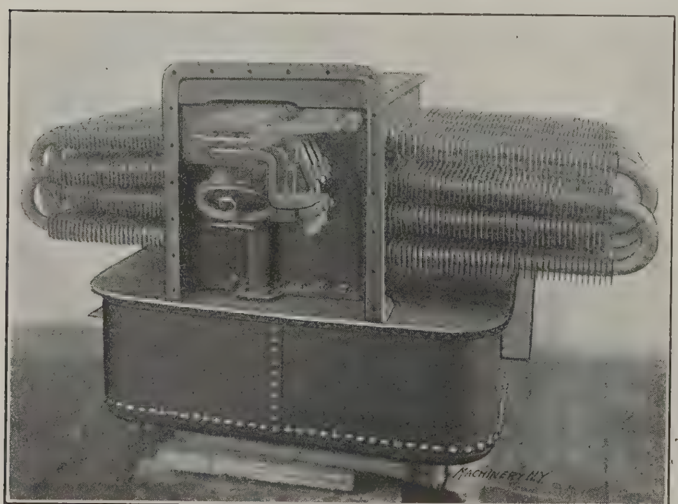


Fig. 7. Water Rheostat.

lines and the electrified railways, as it will undoubtedly be several years before all of the railways will use the electric power. Ultimately it may be found best to utilize motor cars more extensively instead of locomotives, but during the period of change from steam power to electric power the electric locomotive is considered to be the best, as more flexible, where both steam and electric systems of propulsion are in use.

The first six electric locomotives to be placed in service in the Simplon tunnel are of the gearless type, the wheel axles operating at the same rotary speed as the electric motors. These new locomotives have a double set of coupling rods and cranks with two pairs of motors connected in "cascade" and mounted, one pair on each shaft side by side. Each shaft runs in rigid bearings in the frame, the motors being mounted midway between the three driving axles with their centers about 9 inches above the level of the wheel centers, leaving space for an outside stator 1½ feet in diameter greater than if directly coupled to the axles. Each locomotive has a pair of very stiff coupling rods with direct connection by cranks to the two motor shafts.

Two balanced weights are provided for counteracting the weight and centrifugal force of each of the side-rods, these weights also balancing the motor shaft cranks. Dead points are avoided by having the cranks set at ninety degrees and secondary coupling rods are provided which exert horizontal driving forces upon the wheel crankpin.

In addition to the three driving axles these Simplon tunnel three-phase locomotives have each a trailing pony truck and a leading pony truck with a single axle and a pair of wheels 33½ inches diameter. These locomotives each weigh 124,000 pounds, the three driving axles each having wheels 60 inches diameter and carrying together about 84,000 pounds of the total weight of the locomotive.

* * *

SOME METHODS OF MAKING WROUGHT METAL CAR-WHEELS.

E. D. SEWALL.

In the fourth and fifth decades of the 19th century, while railroad transportation was still comparatively new, and the weight and strength of cars were being rapidly increased, the

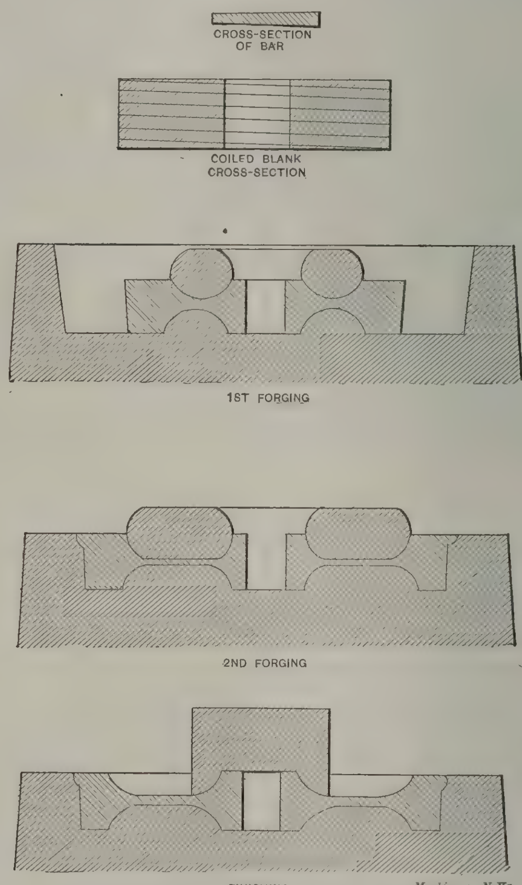


Fig. 1. Early French Method.

problem of making safe and durable car-wheels enforced itself upon engineers, and its solution was widely sought. Very naturally attention was then directed to the production of integral wheels of wrought metal, and although it would appear to be a simple enough matter to forge or press a car wheel, practical difficulties arose in attempts to make so comparatively large and complex a die-forging within reasonable cost and of such quality as to warrant intrusting to them human lives.

Successful methods of making car wheels of cast iron, suitable for the weights and speeds of that period, were then de-

vised, which destroyed for the time, and long postponed the demand for an integral wrought wheel, until, in recent years the higher train speeds, greater car weights, cheaper steel, and improved methods have encouraged the commercial manufacture of wrought steel car wheels of great durability.

One of the earliest methods of making wrought car wheels, patented in England, consisted in heating a circular slab of wrought iron, or a pile made of bars and scrap, thicker but of smaller diameter than the wheel, placing the slab in a die very roughly approximating the shape of one side of a car wheel and compressing or hammering it by means of a die of similar configuration. The rough shaped blank thus formed was repeatedly heated, placed in properly shaped dies, and hammered progressively all around by hammer dies having the shape of a sector of the wheel blank, and finally compressed at a low heat in a finishing die by a hammer of proper

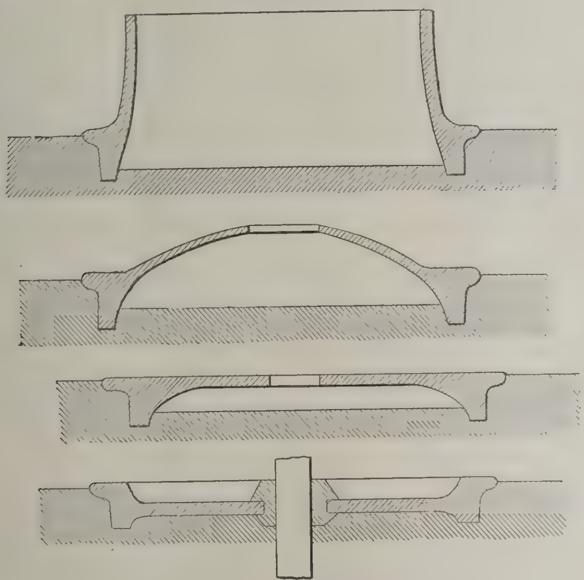


Fig. 2. Early English Method.

configuration. When the forged blank became cold the axle hole was bored and the tread turned in a lathe.

With the design of obtaining a wheel of very high quality, the following method, shown in Fig. 1, was developed in France near the middle of the last century. Rolled bars of iron or steel slightly wedge-shaped in cross-section were coiled upon a mandrel into rings having a weight about equal to that desired in the finished wheel. The bar was coiled so that its wide edge would form the outer surface of the coil. By so doing, the stretching of the outer edge and compression of the inner edge, due to the bending operation, thinned the

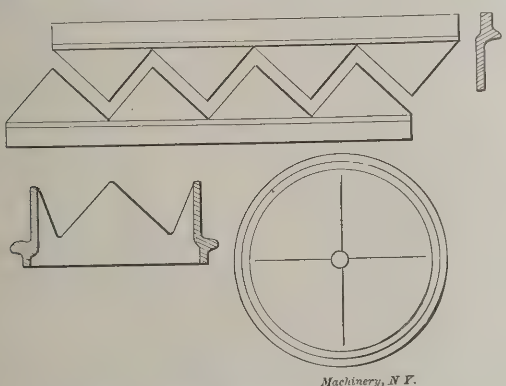


Fig. 3. English One-piece Welded Plate.

outer and thickened the inner edges so that the layers of the coil when wound would become of equal thickness and lie parallel, the wedge section being transformed into a rectangular section. The ring was then heated to a welding temperature and the layers welded into a solid annulus, which, by treatment in different dies, was expanded and forged into a solid wheel.

Another English method of making wrought car wheels from previously worked iron consisted in rolling a bar having a section which, on one edge, was that of the tread and flange of a car wheel, and the remainder of which was a plate of the thickness of the web and of a width equal to the radius thereof, but lying in a plane parallel with the tread surface, instead of perpendicular thereto, as in the finished wheel. See Fig. 2. A suitable length of such bar was then bent into ring form and its ends welded together. The cylinder thus formed was then placed in a die shaped to conform to the tread and flange portions. The web portion was then bent

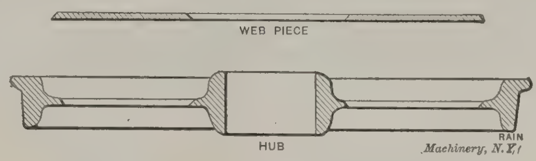


Fig. 4. French Three-part Wheel, Welded.

inward by means of cup-shaped drawing dies into the approximate shape of a car wheel but without a hub. A wrought metal tube was then inserted in the central opening and upset by properly shaped dies to the form of the finished wheel. The blank was then reheated and welded into one mass.

A similar English method (Fig. 3) consists in rolling a plate having a thickened tread and flange portion on each edge. From this plate two shapes, each suitable for making a wheel were sheared by a zigzag cut lengthwise of the center. Each shape thus formed had four triangular projections on one edge, the point of each projection forming an angle of 90 degrees, and on the other edge the thicker tread and flange portion. This scalloped bar was then bent and its ends welded together. The four projecting triangular portions were then bent inward and forced downward until the edges of the triangles met and formed the web of a wheel blank. A hub piece was then inserted and the whole heated and welded in suitable dies.

In order to avoid the difficulties incident to forging a large slab it was early proposed in France to separately produce a wrought hub, a wrought rim, and a web stamped from rolled plate, each having beveled edges to provide for lap-welding the

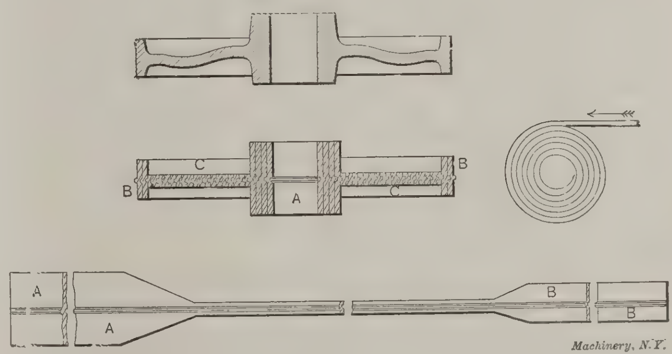


Fig. 5. Krupp Wheel Structure.

parts together. These three parts were then assembled in a matrix having the contour of the wheel, as indicated in Fig. 4, and the whole welded and finish forged into a wheel.

By the German Krupp method (Fig. 5) a long bar was rolled of a length sufficient when coiled upon itself to produce a disk equal in diameter to the intended wheel. Each end of this bar was wider than the main portion, one end, *A*, being of a width equal to the depth of the hub and the other, *B*, equal to the depth of the rim. This bar was preferably rolled with a groove on one side and a corresponding rib upon the other. It was then wound upon itself over a mandrel, the wider end forming the inner portion for the hub, the outer end forming the portion for the rim, and the intermediate portion, *C*, forming the web. The rudimentary wheel thus formed was heated white hot, placed in a matrix and welded and forged into a car-wheel for which great strength and durability has been claimed.

With the increasing use of steel as structural material, methods of making car-wheels from solid masses of steel have been developed. Most of these methods have consisted in casting a steel blank approximating the wheel in size and shape, and then rolling the web and tread, or the tread alone, to weld the pipes and blow-holes, which are incident to steel castings, and to compact the surface metal. Some processes, however,

contemplate more thorough working of the steel for the purpose of securing greater strength, and to couple with this thorough kneading such rapidity of operation as to enable the production of a wheel at a single heating to save time and labor and to avoid waste of metal by oxidation. In most of these processes a steel ingot is first cast of a length considerably greater than the thickness of the hub, and of a diameter much less than that of the wheel.

Fig. 6 illustrates a method which starts with the production of a steel ingot which is pressed or hammered into a flat disk of about the thickness of a car-wheel. As the pressure applied endwise on this ingot will somewhat stretch the periphery and possibly develop cracks or radial checks therein, the disk is set up on edge and hammered by dies shaped to form the tread and flange and solidify them. The axle hole is then punched, the blank placed flatwise in a properly shaped die and pressed therein by a mating die into the form of a finished car-wheel. In this process two heatings are necessary, a high heat for the rough forging and a low heat for the final pressing and finishing.

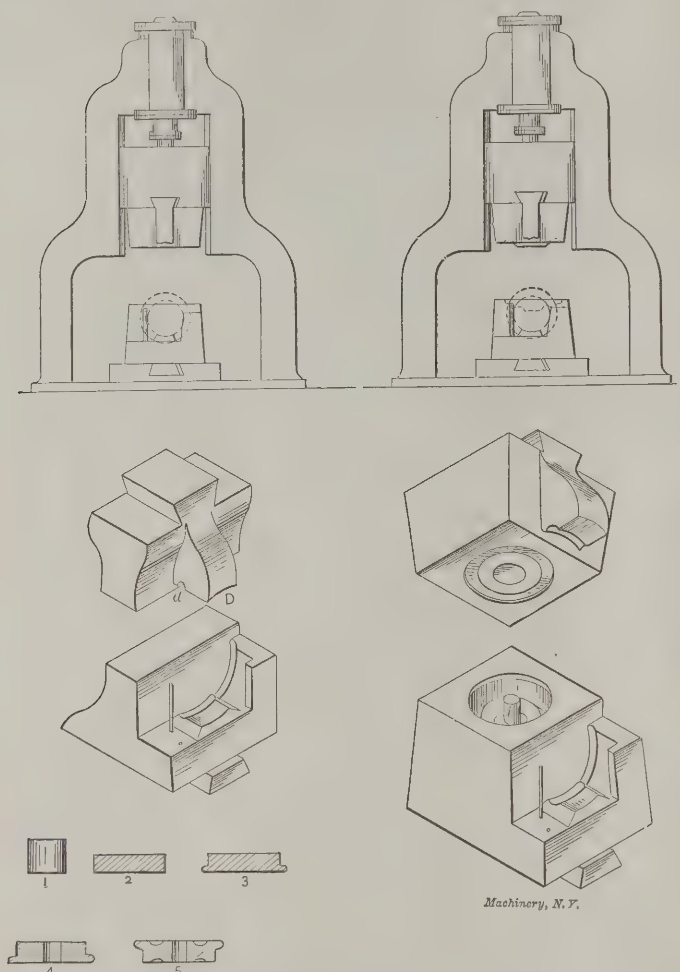


Fig. 6. Steel Ingot Wheel Making.

Another method designed to finish forge a steel wheel at one heat is illustrated in Fig. 7. This method consists in taking an ingot of metal of suitable size and shape, preferably round or octagonal, and placing it with its axis perpendicular to the faces of flat dies and by vertical blows bringing it to a diameter slightly less than the diameter of the blank and of somewhat greater thickness. Then convex forming plates are placed successively upon the upper flattened faces of the blank, which, under the action of the hammer, displace metal and form the rudimentary flange. The lower die, with its centering-plug and shoulder, is changed into a forming die by placing upon the shoulder a wall-ring bored to the form which the tread and flange is to take. Into this forming die the blank with its rudimentary flange is placed. The blank is driven home into the wall-ring so that when the onset of the dies is complete the flange is turned downward and outward. The flanged blank is then turned upside down and pressed out of the wall-ring. Then it is placed between dies having raised collars on their working faces of similar section and size, surrounding and concentric with the hub pocket. The lower die is so formed that besides the collars its top forms a centering plug and shoulder for the wall-ring. By

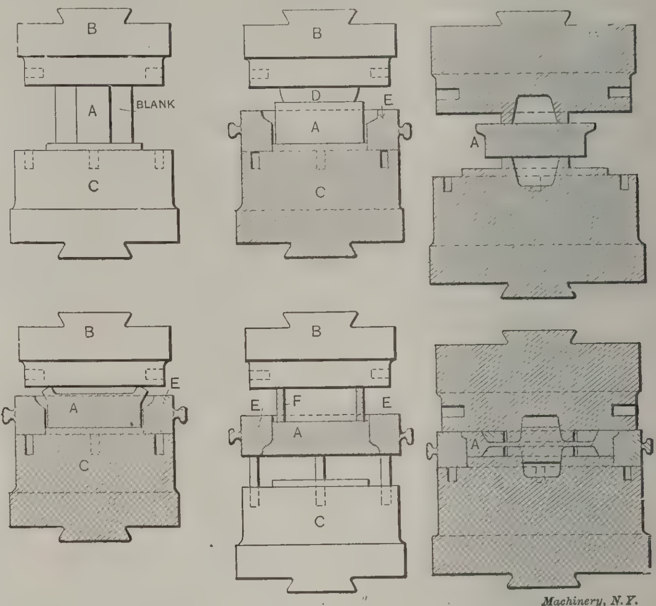


Fig. 7. Steel Ingot Wheel Making.

the action of the dies the metal around the hub is displaced and forced radially outward into the rudimentary rim, leaving part of the plate between the collars. The rim and web are enlarged by means of loose plating rings or collars used in pairs between the dies. Successively larger pairs of rings are used until the forging is almost equal in diameter to the finished wheel. The forging is then removed and upon the

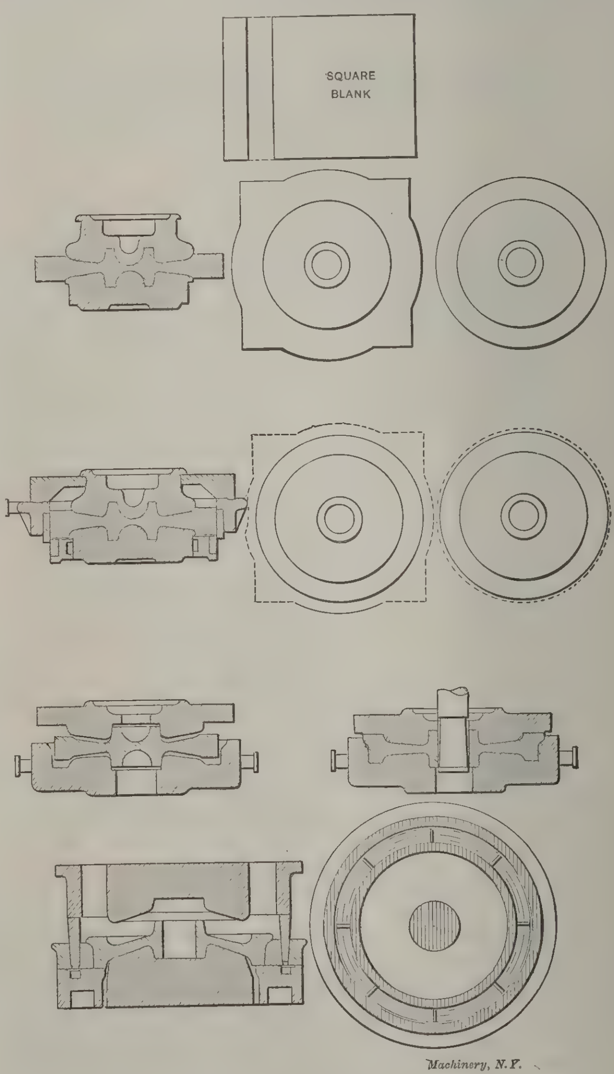
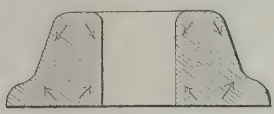


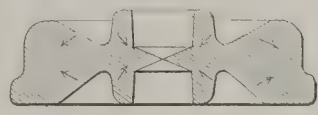
Fig. 8. Schoen System.

shoulder of the lower die is placed a wall-ring which is so made that when in position it alters the die to a finishing die. The upper die and lower die with the wall-ring, and a final pair of collars, form a matrix for the finished wheel. The forging is then placed therein, resting upon one of the loose collars. The mate of this collar is then put in position on top of the forging. The upper die is lowered, driving the collar home, thus forming the finished wheel.

drawn blank is then flattened out and the tread portion forged in dies.

A recent invention in making forged steel wheels starts with an annular ingot of steel considerably thicker and less in diameter than the finished article. By this method it is designed to forge the completed wheel at one heating. The central opening in the ingot is designed to receive the excess of metal flowing into it from the forging operation and the





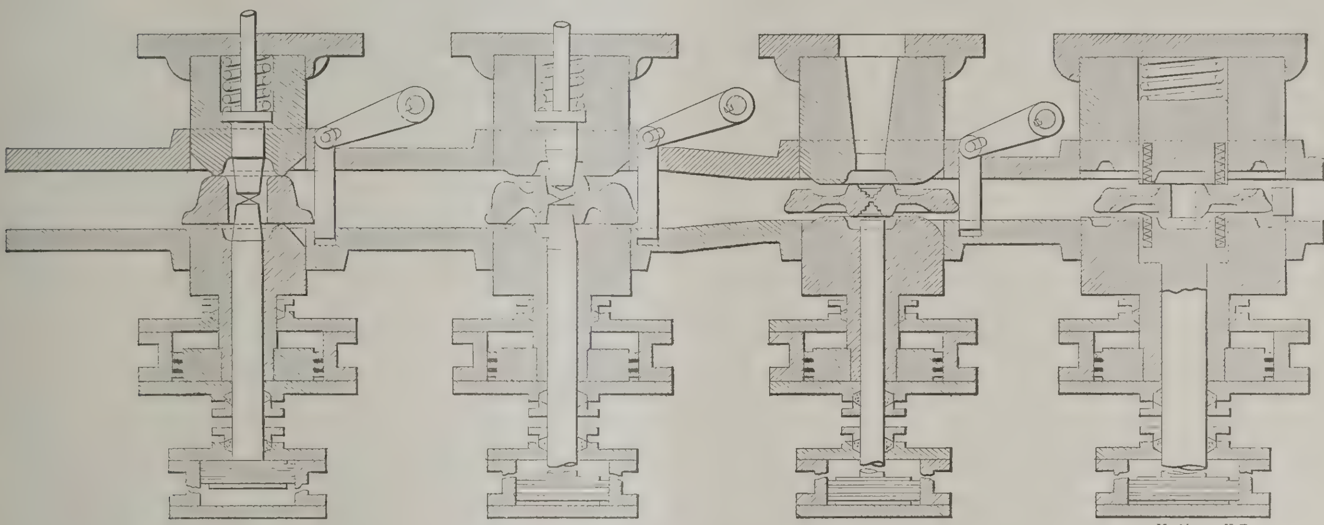


Fig. 9. Method for Making Car-wheels by one Heating.

In the German Ehrhardt method (Fig. 10) a hot ingot or blank of steel, (or several of them), of square or hexagonal section, of a weight equal to that of a finished car wheel, is placed in a cylindrical die and a hole punched through by means of an expanding punch. One of the rings thus formed is then placed in a matrix having the shape shown, and a plunger having a projection on its end considerably smaller than the opening in the annular blank is brought down upon

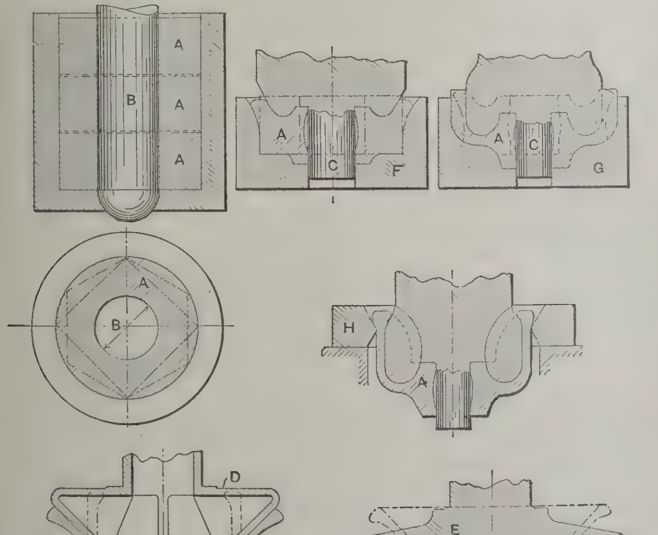


Fig. 10. Ehrhardt Method.

it, thus shaping the blank and causing the metal to flow both outward and inward, thus providing for a very rapid reduction. The blank is then placed in another die and another plunger forced into it, cupping the blank still more. This cuplike blank is then forced through a draw die by means of a properly shaped sectional punch and the walls drawn so as to lay the fibers parallel with the die axis, thus imparting to the blank the tough fiber resulting from drawing steel. This

pressure of the dies is so distributed that the interior portion of the ingot will be forced to the central opening whence the most of it may be subsequently removed by the punch when the axle hole is made, and whatever may remain will be in a position where it cannot materially weaken the wheel. The series of dies are illustrated in Fig. 9. In the center of each of the two preliminary pairs of dies are punches spring pressed toward each other. When the annular portions of the dies enter the hot metal it flows outward toward the rim and also inward against the punches which yield to excessive pressure. The metal is thus allowed to flow freely, rapid forging is thereby accomplished and the poorer portions of the ingot squeezed into the central opening whence it is removed by the punch which sizes the axle opening.

In the Schoen method, Fig. 8, the blank is obtained from selected rolled stock free from pipings and other defects. The blank is sheared of a size greater than the wheel and by the first operation is die-pressed to form a rudimentary hub and the web adjacent to the hub. In this operation the metal is spread radially, but the excess of metal around the outside acts as a confining band, thus preventing the checking that is apt to occur when the diameter of a metal blank is increased by expanding it. After the preliminary forging, as above, the blank is sheared to the size of the wheel. It is then examined for defects that may possibly be developed by the spreading action of the dies. Such defects, if there be any, may be readily detected on the sheared surface and the blank then discarded early in the process before much work has been done upon it. The blank, if perfect, is then confined around its edges and other dies brought into action to complete the exterior of the hub, reduce the web and form a flanged rim. When the dies have been closed to perform these operations, a punch is forced through the center to complete the axle hole. The forged wheel is then subjected to the action of a rolling machine to finish the reduction. The wheel is then dished by means of dies, and the thread trued by segmental die sections forced radially against the tread. During this truing operation the faces of the die segments are treated with oil, which with the comparatively cool dies has the effect of chilling the rim, and the tread is completely finished without any subsequent machining.

D., N. & P. RAILWAY ROTARY SNOW PLOW.

The snow conditions this year on the northern transcontinental lines are the worst experienced in ten years, and at this time the rotary snow plow is one of the most important features of the equipment of those roads. These mechanical snow fighters have played a most important part in the history of railroading in the West, and have greatly benefited conditions attending the use of the wedge plow. The rotary is adapted to removing snow of any character and of any depth, quickly and easily, with no danger to equipment or men. To cope with drifts 15 to 20 feet high, something besides brute force is required. The old method of bucking drifts of this character with the wedge plow with six or seven heavy locomotives behind it, resulted in many casualties among railroad men engaged in this dangerous work. The rotary will bore its way through drifts packed in a hard icy mass in front of the plow with perfect safety to those operating it. Except in the most extreme conditions, one heavy consolidation locomotive provides sufficient power for its propulsion. The rotary herewith illustrated is the largest ever built, and was recently completed at the Cooke Works of the American Locomotive Company for the Denver, Northwestern & Pacific Railway. This plow will clear a cut 13 feet 4 inches wide. The wheel consists of ten cone-shaped scoops, fitted with knives which adjust themselves automatically into cutting position. The wheel is encased in a drum, which is provided with a reversible hood operated by an air cylinder, so that the hood may be turned to either side to suit the direction in which the wheel is turning. The boiler is of the locomotive type with Belpaire firebox. The engine consists of two horizontal cylinders with slide valves operated by the Walschaerts valve gear. The plow is carried on a steel I-beam frame, and is mounted on two 4-wheel steel frame trucks. To prevent the derailment of the plow, the front truck is provided with ice cutters and flangers. The ice cutters are attached to a frame hung on the forward end of the front truck and operated by means of an air cylinder, so that it may be raised and lowered in crossing frogs or switches. The flangers are hung in the rear of the truck and connected to the axle and are also operated by an air cylinder. With the ice cutter and flanger in perfect working order, it is absolutely impossible for the rotary to be derailed by ice or snow. The halftone, below, of a cut made by one of these plows, shows the clear rail which they leave.

Fig. 1. Cut in Huge Snowdrift, made by the Rotary Snow Plow.

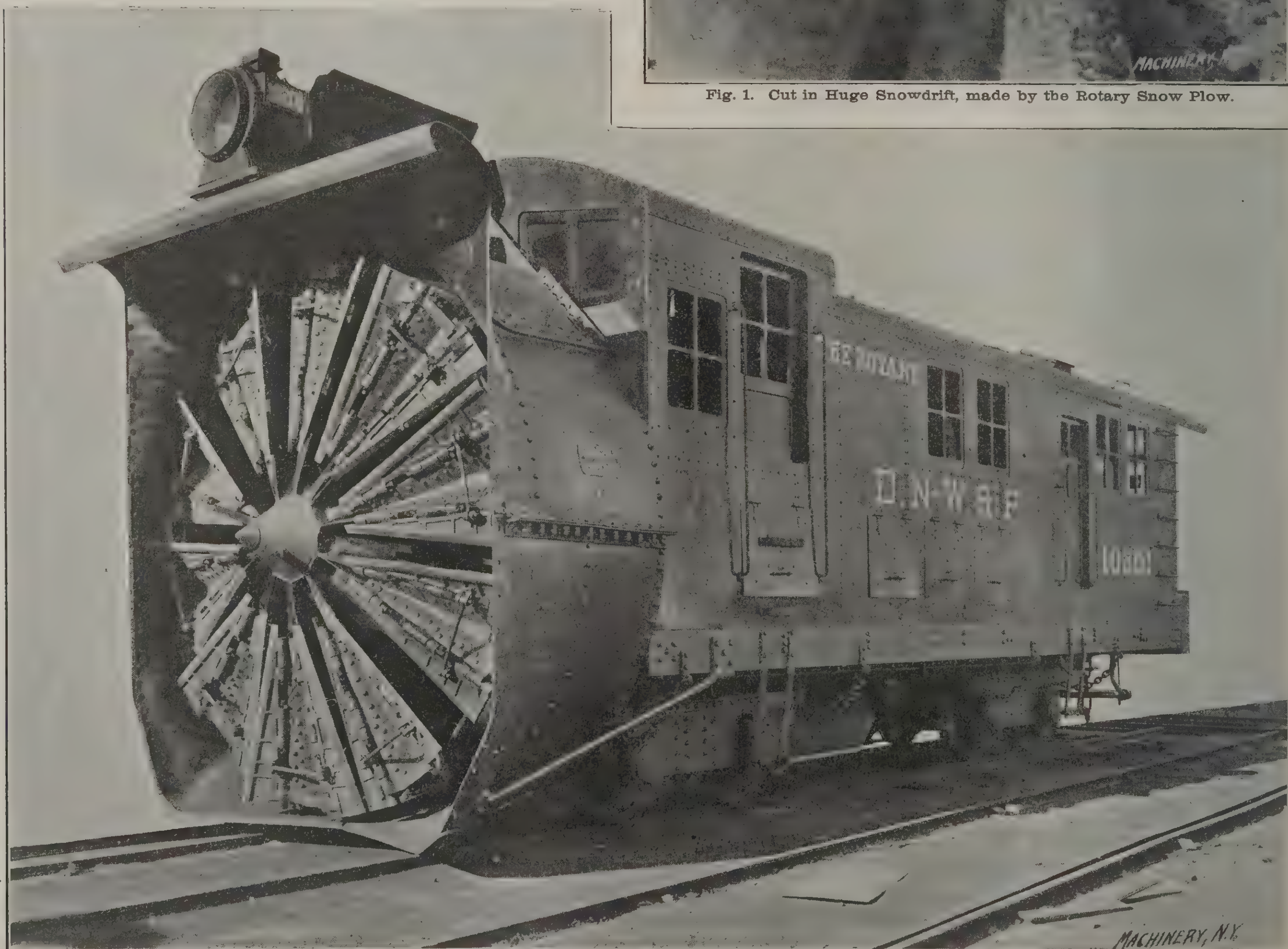


Fig. 2. Denver, Northwestern & Pacific Railway Rotary Snow Plow, built by Cooke Works of the American Locomotive Co.

THE MANUFACTURE OF SHOT-GUNS AT THE ITHACA GUN COMPANY'S WORKS.

W. L. McLAREN.

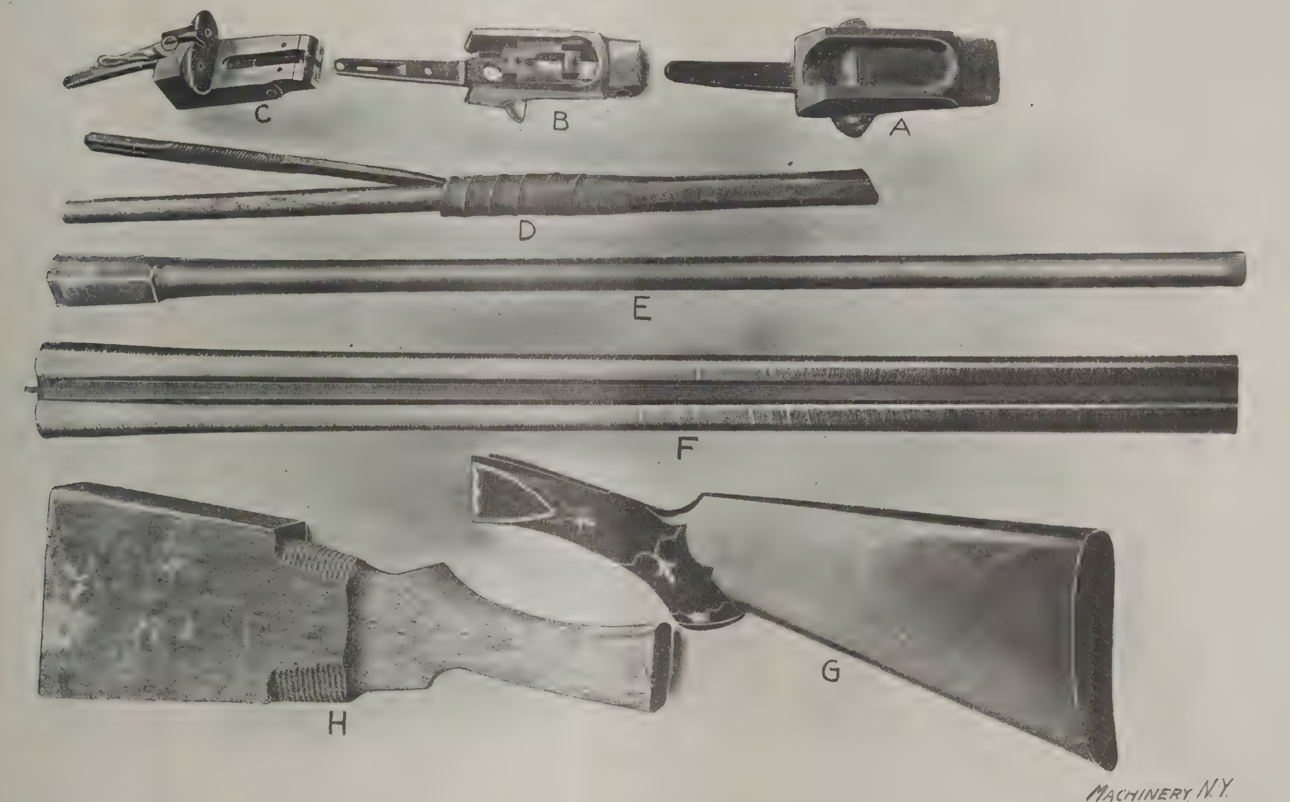
The accompanying halftones show some views taken recently in the works of the Ithaca Gun Co., Ithaca, N. Y., and will serve to help in conveying an idea of this branch of manufacture as it impressed the writer. The Ithaca Gun Co. was established in 1880 and incorporated in 1904. The business was started by Messrs. L. A. Smith and George Livermore, and is entirely devoted to the manufacture of double-barreled shot-guns of different sizes and grades. No cheap guns are manufactured, but only high-grade fire-arms, many of which are highly ornamented and finished, and priced as high as $300.

The barrels are all imported; they come in boxes containing 50 pairs of barrels each, rough-turned and rough-bored to within 0.030 inch of finished size. The lower-priced guns are fitted with the famous Cockerill steel plain black barrel; then, next in price comes the laminated twist steel barrels; then in order are barrels of Damascus steel, following which in quality come the Krupp-Essen fluid steel barrels with their stamped trademark showing a little soldier holding a gun; the last and highest grade in price are the guns with Whitworth fluid steel barrels, these barrels all being numbered and accompanied by a certificate. In case of breakage or failure through a flaw "it is up to the manufacturer" to replace them.

The first operation on a pair of shot-gun barrels is to turn them to size, and then to chamber the breech for the cartridge shell. It requires at least five operations to remove the 0.030 inch stock left by the barrel makers. After being bored to size the barrels are hand polished with emery and the opposite sides of a pair of barrels are milled for the lug which is brazed in. The steel rib joining the barrels is then brazed in and the assembled barrels are mounted in the milling machine and the rib milled concave. The next operation is "matting" the rib, which is done on a special machine, the top surface of the rib being knurled or matted with a single revolving tool mounted on the end of a spindle controlled by a cam. The cam causes the tool to raise and lower every half revolution to conform to the concave surface of the rib. The table is fed one mat cut for each revolution of the tool, producing much the same effect as a knurling tool would on circular work. This machine is one of many special machines designed and made by the company for the manufacture of shot-guns.

After going through various milling operations on the lug, the barrels are polished and sent to the finishing room where they are rusted with chemicals from five to six days, according to weather conditions. This rusting brings out the figure or pattern of the barrels; the iron blackens while the steel shows white, producing the well-known twist and Damascus effect. The fluid steel barrels of course show no such variations of color and are finished to a dead black.

The frames are received in the shape of rough drop forgings and are mostly machined by milling operations. One interesting operation on the frames is that of forming the "ball," as it is called, on each side of the frame. The table of the milling machine is fed longitudinally until the work reaches the point where the ball is to be machined. Here a trip is thrown which engages the circular feed of an auxiliary table and an instant later another trip is sprung, throwing out the first feed. Of course the reason for throwing one feed in before letting out the other is to avoid leaving a mark on the surface, which would surely follow the stopping of the first feed before throwing in the circular feed. The frame now revolves through a half circle while the cutter mills both the flat and the curved surfaces. Various shaped cutters, according to the style of the frame, are used, the principle of the cutters being a combination of a plain and corner-rounding cutter. The ball formed is in reality a quarter of an ellipsoid. The diameter, measured vertically as the gun is held in shooting position, is about as 5 is to 4 to the diameter in the other direction. To get this curve requires some careful calculation and setting, and there are four of these special milling machines for this particular operation.



A.—Rough-forged Frame. B.—Milled Frame. C.—Finished Frame. D.—Barrel under Construction, showing Belgian Method of Forging. E.—Imported Rough Tube for Barrel. F.—Pair of Finished Barrels. G.—Finished Stock. H.—Stock Partially Turned.

There is a slot in the lower side of the gun frame where the lug of the barrel fits when the gun is closed and locked. For years this slot had been machined by milling and broaching, until very recently a Hendey-Norton oscillating milling machine, as shown in Fig. 4, was installed for this work. This machine does the job in quick time and very accurately. The cutter is mounted on the end of a U-shaped arm attached to a spindle which oscillates. The center of the cutter is coincident with the extension of the spindle axis. Various sized cutters are used, of course, for various sized slots; the teeth have no clearance and cut in both directions. The holes for the slots are drilled first, the same as formerly. The slot

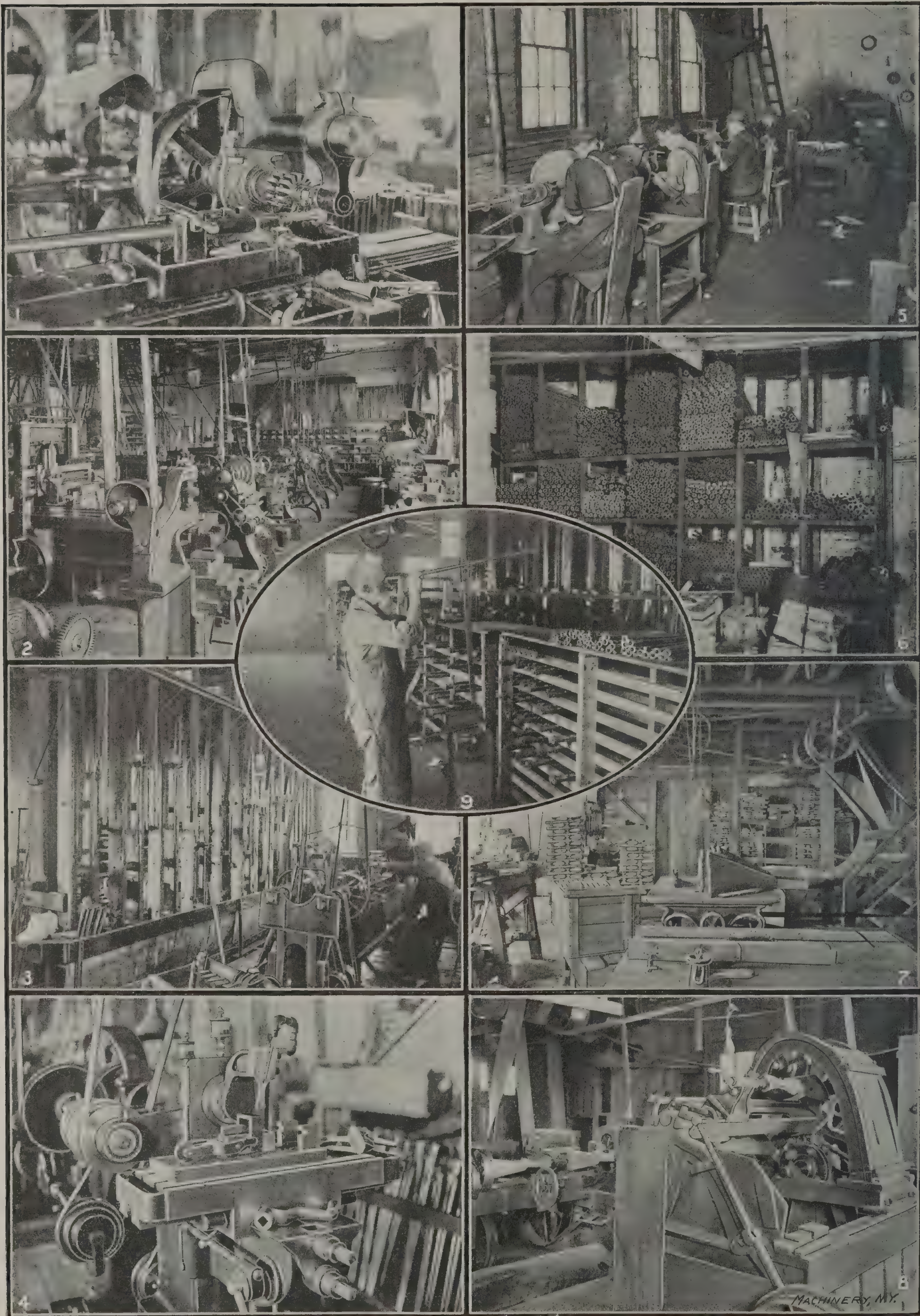


Fig. 1. Taking Straddle Cut on Lug in Milling Machine.
Fig. 2. Toolroom.
Fig. 3. Upright Gun-barrel Boring Machine (to the left).
Fig. 4. Oscillating Miller.
Fig. 5. Polishing Room.
Fig. 6. Barrel Stock-room.
Fig. 7. Stock and Fore-end Forming Department.
Fig. 8. Stock-turning Machines; to the left is the Rough-turning Machine and to the right the Finishing Machine.
Fig. 9. "Bob" Edwards, Veteran Barrel Borer, straightening Tubes before Brazing together.

that is worked out by this operation is plainly shown at C, in the first cut, it being the rectangular slot in the center of the machined frame. The work is mounted on the table and fed up while the cutter oscillates back and forth, removing the metal with each forward and backward stroke. In this manner it is possible to machine by an operation analogous to milling those parts which an ordinary milling cutter could not reach. (For a description of the Hendey-Norton oscillating miller see MACHINERY, April, 1905.)

The smaller parts of the guns such as triggers, guards, and lock mechanisms, are either drop forged or punched from steel stock; all parts are made from the best grade of steel obtainable. Each piece, except the smallest parts of a lock, is numbered and this system of numbering extends to the wooden stock and fore-end. The frames are not casehardened until after being fitted to the stocks. The casehardening process requires 2½ to 3 hours heating in the fire and is done in a pack of bone and charcoal. It requires an experienced man to produce the beautiful effects so noticeable on the casehardened parts of guns. The trigger guards are blued chemically.

The stocks and fore-ends are made of black walnut, the wood being mostly imported. They are rough turned on a rough turning gun-stock turning lathe, and are then passed on to another machine which completes the operation, both these machines, of course, being essentially of the Blanchard type of turning lathe. Next the stocks go to the inlaying machine which carves out the recesses for the inset metal parts to fit in. At H is shown a stock partly turned, and at G is one finished so far as machining is concerned, the rest of the finishing work before done by hand with sandpaper, etc.

The shop is driven by a 21-inch Morgan & Smith waterwheel working under a 39-foot head at 390 R. P. M. At this speed and head the wheel develops about 105 horsepower. A steam plant is also provided to run the works if necessary during low water periods, but it is seldom called into service. During the busy season in the fall and winter the plant runs night and day, the average production being about 80 shotguns a day.

While being shown through the works I was introduced to Mr. Bob Edwards, foreman of the barrel boring department, who is, I am informed, the oldest gun borer in the United States. Fig. 9 shows him in the characteristic attitude of examining a barrel and indicates the simple, not to say primitive, equipment with which the delicate work of straightening a barrel is done.

Mr. Patch, the superintendent, who has been with the company over twenty-three years, informed me that there are over 100 separate milling machine operations on each gun and these operations of course do not include the many drilling, reaming and other operations.

* * *

Plumbers' solder, or wiping solder as it is commonly called, is composed of 40 per cent tin and 60 per cent lead. It has the interesting and valuable feature that at certain temperatures it takes the form of a pliable mass, allowing it to be easily handled and molded to produce the characteristic form of plumber's wiped joint. This operation of wiping is briefly described by the *Valve World* as follows: "The parts to be joined are first freshly tinned at the points of contact, to remove the oxide, and then firmly placed and secured in position. The melted solder is poured on the parts for the purpose of heating them. As the parts become hot the solder becomes cool, taking on the pliable form above mentioned, and is easily manipulated by the mats in the hands of the mechanic, when the joining is completed." It might be added that the ability to make a wiped joint is the principal stock in trade of the average plumber as distinguished from a steam fitter, and that no good reason for maintaining this ancient method of making plumbing connections exists in general. There are a number of mechanical joints on the market which have the merit of cheapness, ease of application, and which can be readily disconnected in case of needed repairs. Needless to say, the plumbing fraternity have worked tooth and nail against the general adoption of this needful improvement, which is bound to come sooner or later, nevertheless.

A MID-WINTER PICNIC AT SANDY HOOK.

R. E. F.

When secretary and president-to-be Hutton, at the Wednesday morning session of the A. S. M. E., finished his explanation of the pleasure and instruction to be derived from the trip to Sandy Hook, I was so much impressed that I immediately made my way to the desk on the floor below where the tickets were sold, and bought one. I was pleased to discover, after some questioning, that the ticket was good not only for the railroad journey but for lunch as well—going at least, and perhaps on the way back also. The day before the event, Thursday, was very nasty, and it had begun to look as though the party for the proposed trip would be a small one, but Friday morning dawned bright and clear with nothing more disagreeable in sight than a 40-knot breeze and a temperature hovering around zero, so a majority of the members changed their minds about staying in town and hastened to the ferry station instead, where a great many tickets were sold. Some of them took their wives and other female relatives with them, despite the warning Prof. Hutton had given that it was likely to be a disagreeable trip for them.

There were ten cars in our train when it left the station of the Central Railroad of New Jersey at Jersey City, and they were all just about full. Probably there were 600 of us, more or less. The train was like most excursion trains, rather hesitating in its movements, and not given to making up its mind very rapidly. It hesitated some time before it worked up courage to cross the draw in Newark Bay, and had a still longer period of indecision before the combined efforts of the train force and the earnest prayers of the excursionists, gave it courage to cross the Raritan at Perth Amboy. During this state of indecision, we were out on an open causeway with no obstructions of any size between us and the North Pole whence the wind was coming. Some people in our car had friends in the next, and some people in the next car had friends in ours, so we were never in any doubt as to what the weather was outside. It must be said, however, that this deliberation of movement had the advantage of giving us all a very clear and vivid impression of the geographical features and industrial development of western New Jersey.

Enter—The Caterer.

It was about this time, an hour or so from the time the train started, that the caterer began to show signs of life. We had been wondering for some little time how he was going to handle us all, but he evidently knew his business. The front car appeared to be his storehouse. At intervals of two or three minutes a procession of waiters would pass along the aisle, some of them carrying large packages of square pasteboard boxes, and others with things in their hands that looked like watering pots with the sprinklers removed. From such of these pots as had their spouts turned in my direction it was possible to detect an odor which at once detracted one's attention from the landscape outside of the window. Two bundles of boxes and two watering pots were deposited at the rear end of each car, and then the distribution commenced. Each member of the party was given a box about 6½ inches square and a little glass of drinkable —either red or yellow, according to his principles. The caterer displayed very good judgment in deciding on the contents of these little boxes; each contained a napkin, a dried beef sandwich, a chicken sandwich, two hard boiled eggs, a little package of salt and pepper, a small cake, a big red apple, and a pickle. After one box had been emptied it was entirely possible to get another. After this we arrived at Sandy Hook.

Special Courtesies to Foreigners.

When the train stopped at the entrance to the government reservation out on the bleak and windy sea coast, a number of the military officers of the place were there to welcome us. Here again we stayed several minutes, during which time our interest was diverted by the passage through each car of a member of the party deputed to inquire of each if, on his word of honor, he would be willing to admit that he was an American citizen. Every one in our car seemed to be guilty,

but apparently this was not the case throughout the train, for a few minutes later an officer, accompanied by a soldier with a megaphone, made his way down through the aisle with a train of attending foreigners behind him. As he entered each car he announced: "Will all members of the party in this car not citizens of the United States please attach themselves to the party which I am to lead? Special courtesies will be shown them." After the excitement caused by this incident had had plenty of time to die away, the train started up again and we made our way toward the north end of Sandy Hook, where the proving grounds and the fortifications of Fort Hancock are located.

An Interview with a Big Gun.

First the train was backed up on a long Y-track to the place where was set up the great 16-inch gun recently built for coast defence service. Here Brigadier-General Crozier, Chief of Ordnance, met us and, as we assembled on the platform around the breech of the big gun, made a little address of welcome, giving a brief description of the manufacture and capabilities of this immense piece of ordnance. After a lot of figures as to weights, muzzle velocities, powder pressures, etc., which slip out of one's mind as rapidly as they are given, he told us that the gun had been built to see whether we could do it or not. He was happy to be able to tell us that the experiment had been a complete success in every particular; that the various laws relating to gun design and construction which had proven true in the case of small sizes had also held good in this, and that all the calculations had been found correct. He told us that so far as any present vessels of possible enemies are concerned, 12-inch guns are big enough, so for the present no more of the 16-inch size are to be built. It is a pleasure and a satisfaction to know, however, that we can build them if we want to.

The gun is a monster. Some of the party climbed up on top of it and went out to the overhanging end. Two or three other inquisitive ones piled a couple of boxes on an empty barrel and climbed to the top for a view into the throat of the creature, at imminent risk of having their shins barked for their pains. A crank was applied and the breech was opened and closed for our benefit. The movements involved in this motion are very interesting. The process is a continuous one. First, a worm meshing in worm-wheel teeth in the breech block gives it a partial rotation to unlock it; the worm is not only a worm in one direction, but is a spur gear as well in the other; as soon as it has ceased to act on the worm wheel, it takes hold of a rack on the side of the breech block and backs it out of the chamber. On reaching the extremity of its movement in this direction, the continued movement of the handle through the action of the connecting bevel gear between the crankshaft and the worm wheel shaft, swings the block and its carrier around to one side, leaving the chamber open and unobstructed for the projectile and the charge of powder. The gun is set up on a temporary foundation in the sand, just rugged enough for the purpose of trial firing.

From here we plowed our way through the sand and dense undergrowth of scraggly, thorny shrubs to the shore, where a couple of targets were set up, one of them being a section of the armor of the Iowa, the other of the battleship Tennessee. These are to be fired on by guns further up the beach to determine the effect produced under varying conditions. We then returned again from the beach to the train, and were taken back to the main line and started for the proving grounds, but not until President Taylor, President-elect Hutton, and Generals Crozier and Murray had had their pictures taken at the breech of the 16-inch gun.

The Proving Grounds.

At the proving grounds we again debarked. Here were all sorts and sizes of rifles, mortars, field guns, rapid-firing guns, etc. These are mounted on concrete platforms with concrete buttresses or bulwarks behind them, presumably provided so that if anything bursts, the fragments will hit the mass of concrete and not go beyond it. Back of these is a high tower of steel with a large room on top from which the firing is directed and observations taken. We passed along the platforms from gun to gun, examining the mechanism, looking into muzzles and working various handles and levers, and then we were all grouped on the concrete structure in back and the firing commenced. A 6-inch rapid-fire gun, throwing a cast-iron shell, was twice discharged. There was nothing very depressing about the report from this gun, and the nervous members of the party began to feel reassured. Next came five rounds from a 15-pound gun fired in remarkably fast time. Two or three other reports were heard from different parts of the platform and then, at a signal from the officer in charge, a 10-inch rifle on a disappearing carriage arose from its bed as lightly and gracefully as a feather, without shock or sound of any kind. After a little delay due to the arranging of the electrical connections of the speed indicating mechanism, the order was given to fire, and we stuck our fingers in our ears and gritted our teeth. A dull, heavy report followed and the gun was down in its bed again. Several seconds after, I neglected to take my watch out so I do not know just how long, out toward the east somewhere a white cloud of spray shot into the air to a considerable height, and a great flock of gulls which had been floating on the water arose, filling the air with the flash of light from their wings. Their excitement could be very plainly seen through the glasses.

Gun Maneuvering and Sub-caliber Practice.

From here we made our way to Fort Hancock, whose batteries we were to inspect. Brigadier-General Murray, Chief of Staff of the United States Army, led the procession and explained the guns and fortifications as we went along. From the front there is little to be seen that would cause one to suspect that dangerous weapons are concealed here; there is a simple bank of sand and nothing else. Down behind it, however, are all the great rifles, crouched on their haunches, ready to spring up and show fight at a signal from the officer who controls them. For our benefit General Murray had one of these monsters maneuvered, he explaining the movements as they took place. The catch holding the gun in its lower position was released and the counterweight threw the rifle into place above the level of the parapet. Then, a light touch on the controller swung the muzzle to the right and to the left, and up and down. Of course when the gun is fired, the recoil seats it again in its recumbent position, but in this case, since no firing was done, it was brought down by hand, two men turning the crank and working hard to do it.

We were then shown some sub-caliber practice. We were told that this sub-caliber practice is largely responsible for the proficiency in marksmanship which the American artilleryman has shown. A small barrel, perhaps 2 or 3 inches bore, is placed inside the chamber of the big gun, being held in a truly central position by supporting disks. The weight and charge of the smaller projectile are such that its trajectory bears a definitely determined relation to that of the large projectile. It is thus as useful for target practice as though the $200 or $300 required for a single discharge of 12-inch ammunition was expended. It was some little time before they could get around to firing this sub-caliber ammunition. The passing body of visitors, not realizing that it was desired to fire the gun, all preferred to pass by its muzzle end, and each one stopped to gaze into the gloomy depths of its throat. Owing to the inconvenience of discharging the gun under such circumstances, everyone was allowed to satisfy his curiosity before the firing commenced. The sharp "spat" of this sub-caliber ammunition was so ridiculous when compared to the heavy reports we had just heard, that a number of us became quite brave, and gathered about the barrel of the gun, even getting to the point of leaning up against it and placing our hands on it. No one, however, showed any further desire to pass in front of the muzzle, although, so far as one could see, that would have been a perfectly harmless proceeding.

Sandy Hook as a Winter Resort.

After this exhibit, a long, chilly, windy walk took us to the mining casemate, where a description of the principles of sub-marine mine defence was given us. One great advantage of this lecture and exhibit was the fact that it was held in a hole in the ground entered only by a tunnel. Although open to the sky, this pit was so deep that there was not much

of any wind. After this respite, we turned our backs on the shore batteries and made our way toward the center of the peninsula where the mortar batteries were located. One could not help thinking, as he plowed through the sand and turned his face away from the biting wind, that life in this part of the world in winter, at least, possesses few charms. The officers and men were going about in fur caps and huge gloves, the women and the children of the post were all indoors, and all the inhabitants except the officers—whose dignity forbade them—seemed to enjoy slapping their chests as long and as hard as they could, when they had nothing else of particular importance to occupy their time. When, however, the soldiers were in line, receiving and executing orders, they were as straight and still and attentive to business, and as little conscious of the elements, as a soldier is supposed to be.

A Salvo from the Mortar Battery.

The mortar battery proved to be one of the most interesting exhibits of the day. The formation of the earthworks is that of a series of deep pits in the ground, possibly 40 or 50 feet deep or more. These pits are connected with each other by tunnels and have smooth concrete sides. At the bottom of each is a group of four 12-inch mortars, looking, as one man expressed it, like a lot of big bull dogs. We were to witness the firing of a "salvo"—that is to say, the simultaneous discharge of four of these guns at one time. It was explained to us that mortars were always aimed by the indirect method; as the enemy's ships are approaching, their range is rapidly obtained, calculations, facilitated by instruments provided for the purpose, are made to determine at what angle and in what direction the mortars shall be pointed, and then, after the aim has been taken, they are discharged. They cannot of course be fired point blank at the approaching vessel, but are aimed up in the air. The missiles go to a tremendous height and, in falling, come down nearly vertically on the deck, the weakest point of the approaching vessel. Strange as it may seem, the science of mortar firing has been developed to such an extent that they are fully as effective as rifles aimed directly at the object it is desired to hit.

Nowhere, as when we were grouped on the verge of these pits, did we realize so well at once the beauty of the day and the force and coldness of the wind. Long heavy swells were coming in from the southwest, whose tops, as they broke on the beach, were shattered by the gale from the north and whirled in a line of flashing spray that extended as far down the coast as the eye could reach. The herring gulls, which swarm the harbors of our Eastern cities during the winter, were flying in great flocks through the air or resting in countless numbers on the undulating surface of the ocean. A couple of huge freighters, from the East Indies perhaps, or some other foreign place, were steadily ploughing toward the great city to the north of us. Nearer in and to the southward, a little tug could be seen making her way toward us along the shore.

Meanwhile they had been loading the four 12-inch rifle mortars below us. The projectiles and powder bags were pushed into place, the breech blocks were closed, and the guns were aimed in accordance with instructions given by the officer who stood with us on the parapet—and then we waited for the firing. These guns looked very business like, all standing at attention with heads up, ready to do as they were told as soon as they were told to. Then came a dull boom and a trembling in the ground, and the pieces were fired. Away up in the sky, so far up that they were almost out of sight (in fact they finally did disappear) were four, or was it only three, little black specks side by side, headed in this round-about fashion for the definite little point out in the ocean at which they had been aimed. A few seconds later a column of spray shot in the air, and we knew that the projectiles were back to sea level again. The little tug shifted its course, and gave us a wider berth.

After this, from our elevated station, we were treated to the sight of an explosion of a mine laid in the sand. So far as one could see it lay in about the direction of the territory we had been tramping over some hours before. Over this same spot were also exploded, one after the other, four shells, two loaded with black and two with smokeless powder. These were fired from a point half a mile further back at the proving grounds. Again, congratulating ourselves that we had gotten away from that spot earlier in the day, we made our way back to the train and started for home.

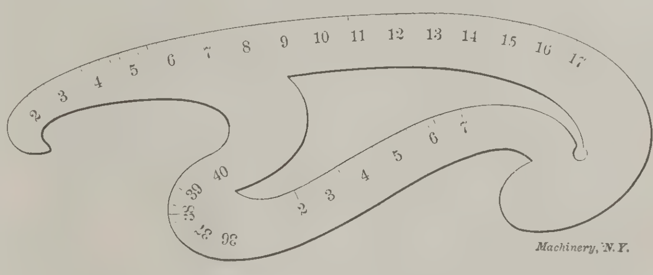
A Lesson in Journalism.

The papers in the city had a surprise for us when we returned. "Foreign spies at Sandy Hook—Attempt by foreigners to witness gun tests at Fort Hancock—Tried to board special train of engineers—Attempt believed, however, to have been foiled."—A sensation was caused when word was passed from car to car that President Hutton was holding up members and guests and requiring them to give evidence of their American citizenship." There were seven of the disappointed aliens in all; two Germans, an Englishman, a Japanese, a Frenchman, a Canadian, and a Scotchman. It seems that they were allowed to witness the tests at the proving grounds, but were entertained during the rest of the day in a comfortable steam-heated room in the post library, while the rest of us were shivering around the fortifications of Fort Hancock. One had the impression at the time that this "special courtesy" that was shown to the aliens was merely a matter of red tape and nothing more, but the newspaper reporters evidently saw a chance to make something startling out of it, and they gave a very interesting exhibition of the way in which most startling news is manufactured.

* * *

GRADUATED CURVE FOR DRAWING SYMMETRICAL LINES.

Many curves drawn by means of the so-called French curve, such as the ellipse, hyperbola and parabola, require that the same parts of the French curve are used on each side of the axis of symmetry. The regularity of the curve and the degree of perfection of the symmetry will then depend on one's ability to reproduce in proper sequence on one side of the curve the parts of the French curve used in drawing the other side first. The cut shows a curve graduated on its edges with some arbitrary divisions, say, in eighths. At every fourth one of these divisions a number is placed, starting with one at any convenient point on the curve and increasing by one until the



Draftsman's Graduated Curve.

graduations come back to the starting point. If the curve is made of celluloid the figures may be put on in black, so that when the curve is turned over with the figures down, they can be seen readily. If the curve is made of an opaque substance the numbers must be put on both sides. The numbers on the back should exactly coincide with the numbers on the face, and should proceed around the curve in the same order. In the cut the graduations are not shown all around the edges of the curve, but in graduating a curve they should, of course, be carried all around.—*Browning's Industrial Magazine.*

* * *

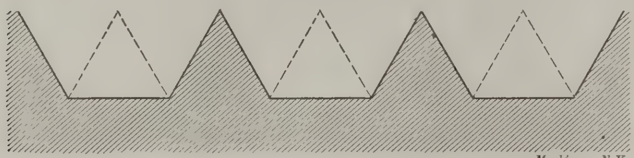
According to recent reports the largest wireless telegraph station in Europe is at present being erected at Norddeich, Germany, by the German postal department. The range of this station will be a circle of 950 miles radius and it will cover practically the whole of Europe, reaching as it will St. Petersburg at the north, and Naples at the south. The height of the tower of this new wireless telegraph station is 275 feet. Experiments undertaken so far have been successful in transmitting messages to steamers on the Norwegian coast, 650 miles away, across the Baltic as well as a considerable portion of the Scandinavian peninsula.

MACHINE TAPS.

ERIK OBERG.

As the name implies, the machine tap is used for nut tapping in tapping machines, the same as the tapper tap which was treated of in the December issue of MACHINERY. It was mentioned in that issue that the names of these two taps are often confused. From a manufacturing point of view, however, there is distinct difference between the two kinds of taps. The tapper tap embodies, in fact, the very simplest design possible for its purpose. It cannot be successfully used in many instances where the machine tap will be satisfactory. The machine tap being threaded and relieved in a different manner recommends itself for use in very tough material, and for heavy duty.

The general appearance of the tap may be seen from Fig. 4. It consists of a threaded portion *B*, having a straight part *D*



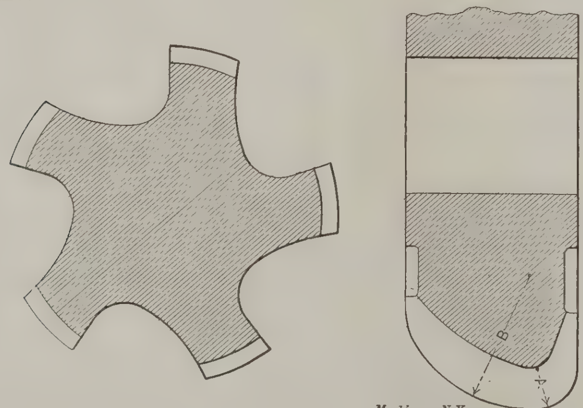
Machinery, N. Y.

Fig. 1. Diagram of the Echols' Thread.

and a chamfered portion *E*, and a shank *C* which is provided with a square, enabling the tap to be securely held in a chuck without danger of slipping. The extreme end of the threaded part is provided with a secondary chamfer, the purpose of which is to facilitate the entering of the tap in the hole in the nut blank. The diameter of the shank should be from 0.01 to 0.02 inch below the root diameter of the thread, the same as for tapper taps and for the same reason, *viz.*, to permit the threaded nuts to slide freely over the shank.

Turning and Threading.

In turning machine taps the straight portion of the threaded part must be left a certain amount oversize. The reasons for this were set forth in the article upon tapper taps previously referred to. The amount which the tap should be left over the standard diameter before hardening may, for general purposes, be between the limits of from 0.0005 inch to 0.0015 inch for sizes not over ½ inch diameter, from 0.001 inch to 0.002 inch for sizes between ½ and 1 inch, from 0.0015 inch to 0.003 inch for sizes between 1 and 2 inches, and from 0.002 inch to 0.0035 inch for sizes between 2 and 3 inches in diameter.

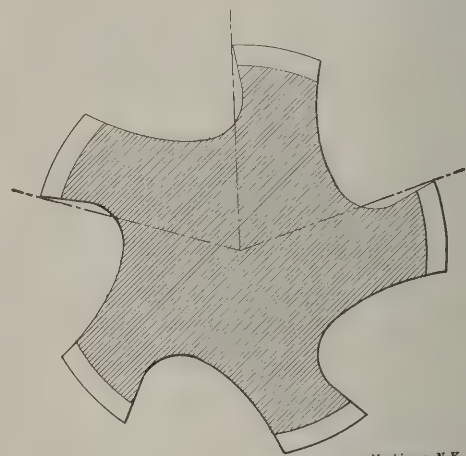


Machinery, N. Y.

Fig. 2. Section of Machine Tap and Fluting Cutter.

The main difference between tapper taps and machine taps will be found in the threading and relieving of the taps. While the tapper tap is threaded straight for the whole length of the threaded portion, the machine tap is threaded on a taper for a certain distance from the point. The length of this taper thread, and also the length of the part chamfered on the top of the thread depends, of course, primarily upon the conditions under which the tap is to be used: the material to be tapped as well as the length of the nut. When making taps in large quantities, however, whether for the market or for shop use in a large establishment, it is evidently impossible to know beforehand exactly what the taps will be used for, and certain standards must necessarily be adopted. Experienced makers of machine taps adhere to the rule of chamfering about twenty to twenty-five threads on the top of the threads and taper the root of the thread for a distance equivalent to eight or nine threads from the point. Formulas will be found below which will give the length of the chamfered part and the length of the taper thread for various sizes of taps; these dimensions will be so selected as to provide for a length equivalent to at least twenty and eight threads, respectively, on standard thread taps.

While a long taper on a tap is desirable in regard to diminishing the amount of stock that each tooth of the thread will remove, it has the disadvantage of making the cutting edges toward the point of the tap very broad with a very small space between them. This impairs the cutting quality of the tap, inasmuch as the action is rather that of reaming than of cutting. It is in order to overcome this disadvantage that machine taps are tapered in the angle of the thread for some distance from the point. This makes the width of the tooth smaller and increases the cutting qualities of the tap considerably. This taper in the angle of the thread constitutes one of the principal differences between the machine tap and the tapper tap, the latter being simply chamfered off on the top of the threads. If we analyze the action of the tap when provided with too many cutting edges we will find that the metal is either ground down very fine, and an unnecessary amount of power is consumed in performing this, or some teeth may



Machinery, N. Y.

Fig. 3. "Hook" Flute.

in fact not cut at all, simply compressing the metal, making the work of removing it still harder for the next cutting edge. On the other hand, a short taper takes away a great amount of the chip room necessary for the removed metal. While this may not be of great consequence in regard to a hand tap where the motion is slow and the tap is often reversed, it is of great importance in regard to machine taps and tapper taps where the cutting speed is high and always in one direction. The tap as well as the nut to be threaded is liable to be injured if ample space for the chips to pass away from the cutting edges is not provided.

An ingenious method of decreasing the number of cutting edges, as well as increasing the amount of chip room, is embodied in the "Echols' thread," where every alternate tooth is removed, as shown in Fig. 1. The removal of every other tooth in one of the lands evidently is equivalent to the removal of the teeth of the continuous thread in every other land of the tap. It is therefore obvious that taps provided with this thread must be made with an odd number of lands, so that removing the tooth in alternate lands may result in removing every other tooth in each individual land. If there were an even number of flutes, the cutting away of the teeth in alternate lands would result in removing all the teeth from certain lands and none from the remaining ones. Machine taps are often provided with the Echols' thread.

Fluting.

In considering the fluting of machine taps we find another difference from the tapper tap. The former tap requires greater strength on account of its harder service, and at the same time as much chip room as possible. The flute that best fills these requirements may, however, not be the flute commercially possible for the purpose, because the factor of

cost is greatly important, and unusual or formed shapes of cutters will cost more in themselves and also require slower cutting speed. In the article about tapper taps, two forms of flutes were shown. Another form of flute introduced by the Pratt & Whitney Co, for machine taps is shown in Fig. 2. This latter form is to be recommended in all cases where a tap of unusual quality is required. The tap will not break as easily, and the chips are carried off in a more satisfactory manner. A certain kind of flute of late used extensively by certain concerns is the "hook" flute, shown exaggerated in Fig. 3. This flute provides for a keener cutting edge, and is recommended for very tough materials. Some users, however, do not look upon this flute as favorably as others, and opinions vary considerably as to the superiority of this flute, excepting if the "hook" be made very slight. It is advisable to make the lands fairly narrow as compared with hand taps, inasmuch as this will increase the chip room and but slightly decrease the strength, the reason for the wide lands of hand taps being not reasons of strength but of good guiding qualities. If provided with a straightsided flute with a radius in the bottom, which is largely used by manufacturers, this radius may be approximately determined by the equation:

$$R = \frac{\sqrt{D}}{6} - \frac{1}{32}$$

R being the radius in the bottom of the flute and D the diameter of the tap. In the case of a fluting cutter such as shown in Fig. 2 the radius A should be about one-eighth and the radius B about one-third of the diameter of the tap for taps with five flutes. For taps with four or six flutes these radii should be slightly larger or smaller, respectively, relative to the diameter of the tap. The numbers of the flutes for various diameters are given below:

Diameter of Tap.	No. of Flutes.	Diameter of Tap.	No. of Flutes.	Diameter of Tap.	No. of Flutes.
$\frac{1}{4}$	4	$\frac{3}{4}$	5	2	5
$\frac{5}{16}$	4	$\frac{7}{8}$	5	$2\frac{1}{4}$	6
$\frac{3}{8}$	4	1	5	$2\frac{1}{2}$	6
$\frac{7}{16}$	5	$1\frac{1}{4}$	5	$2\frac{3}{4}$	6
$\frac{1}{2}$	5	$1\frac{1}{2}$	5	3	6
$\frac{5}{8}$	5	$1\frac{3}{4}$	5	..	..

Relief.

Machine taps are relieved as well in the angle of the thread as on the top of the thread for the whole of the chamfered portion, or in other words, the diameter measured over the heel of the thread should be smaller than the diameter measured over the cutting edge; the diameters measured in the angle of the thread at the same respective places should also differ in the same manner. The straight portion of the thread in a machine tap is for sizing only, the same as in the case of a tapper tap, and should as a rule not be relieved. However, the same as was said about the relief of the straight part of a tapper tap applies here also. In hardening machine taps they should be drawn to a temper of about 430 degrees F. This temperature should, perhaps, vary for different kinds of steel, but the figure stated will be found to constitute a good average.

Dimensions.

In the following are given two sets of empirical formulas for the most important dimensions of machine taps. In the formulas:

A = the total length of the tap,
B = the length of the thread,
C = the length of the shank,
D = the length of the parallel part of the thread,
E = the length of the chamfered part of the thread,
F = the length of the taper threaded portion,
G = the diameter of the tap.

For taps up to and including 2 inches in diameter, the following formulas will be suitable:

$$A = 5\tfrac{3}{4}\,G + 3\tfrac{7}{8},$$
$$B = 2\tfrac{1}{2}\,G + 1\tfrac{1}{4},$$
$$C = 3\tfrac{1}{4}\,G + 2\tfrac{5}{8},$$
$$D = \tfrac{3}{4}\,G + \text{3-16},$$
$$E = 1\tfrac{3}{4}\,G + \text{1 1-16},$$
$$F = \frac{3G + 1}{4}.$$

For taps 2 inches in diameter and larger the formulas will be:

$$A = 3\,G + 9\tfrac{3}{8},$$
$$B = 1\tfrac{1}{2}\,G + 3\tfrac{1}{4},$$
$$C = 1\tfrac{1}{2}\,G + 6\tfrac{1}{8},$$
$$D = \tfrac{3}{8}\,G + \text{15-16},$$
$$E = 1\tfrac{1}{8}\,G + \text{2 5-16},$$
$$F = \frac{2G + 3}{4}.$$

The table below is based upon the formulas given. All dimensions are given in convenient working sizes, and are

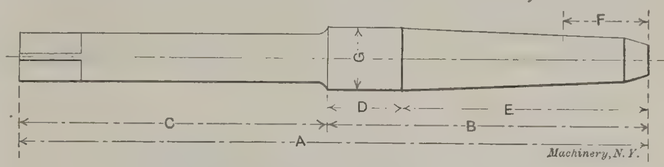


Fig. 4. General Appearance of Machine Tap.

DIMENSIONS OF MACHINE TAPS.

G	A	B	C	D	E	F
$\frac{1}{4}$	$5\frac{5}{16}$	$1\frac{7}{8}$	$3\frac{7}{16}$	$\frac{3}{8}$	$1\frac{1}{2}$	$\frac{7}{16}$
$\frac{3}{8}$	$6\frac{1}{16}$	$2\frac{3}{16}$	$3\frac{7}{8}$	$\frac{7}{16}$	$1\frac{3}{4}$	$\frac{9}{16}$
$\frac{1}{2}$	$6\frac{3}{4}$	$2\frac{1}{2}$	$4\frac{1}{4}$	$\frac{9}{16}$	$1\frac{15}{16}$	$\frac{5}{8}$
$\frac{5}{8}$	$7\frac{1}{2}$	$2\frac{13}{16}$	$4\frac{11}{16}$	$\frac{5}{8}$	$2\frac{3}{16}$	$\frac{3}{4}$
$\frac{3}{4}$	$8\frac{3}{16}$	$3\frac{1}{8}$	$5\frac{1}{16}$	$\frac{3}{4}$	$2\frac{3}{8}$	$\frac{13}{16}$
$\frac{7}{8}$	$8\frac{15}{16}$	$3\frac{7}{16}$	$5\frac{1}{2}$	$\frac{13}{16}$	$2\frac{5}{8}$	$\frac{15}{16}$
1	$9\frac{5}{8}$	$3\frac{3}{4}$	$5\frac{7}{8}$	$\frac{15}{16}$	$2\frac{13}{16}$	1
$1\frac{1}{8}$	$10\frac{3}{8}$	$4\frac{1}{16}$	$6\frac{5}{16}$	1	$3\frac{1}{16}$	$1\frac{1}{8}$
$1\frac{1}{4}$	$11\frac{1}{16}$	$4\frac{3}{8}$	$6\frac{11}{16}$	$1\frac{1}{8}$	$3\frac{1}{4}$	$1\frac{3}{16}$
$1\frac{3}{8}$	$11\frac{13}{16}$	$4\frac{11}{16}$	$7\frac{1}{8}$	$1\frac{3}{16}$	$3\frac{1}{2}$	$1\frac{5}{16}$
$1\frac{1}{2}$	$12\frac{1}{2}$	5	$7\frac{1}{2}$	$1\frac{5}{16}$	$3\frac{11}{16}$	$1\frac{3}{8}$
$1\frac{3}{4}$	$13\frac{15}{16}$	$5\frac{5}{8}$	$8\frac{5}{16}$	$1\frac{1}{2}$	$4\frac{1}{8}$	$1\frac{9}{16}$
2	$15\frac{3}{8}$	$6\frac{1}{4}$	$9\frac{1}{8}$	$1\frac{11}{16}$	$4\frac{9}{16}$	$1\frac{3}{4}$
$2\frac{1}{4}$	$16\frac{1}{8}$	$6\frac{5}{8}$	$9\frac{1}{2}$	$1\frac{3}{4}$	$4\frac{7}{8}$	$1\frac{7}{8}$
$2\frac{1}{2}$	$16\frac{7}{8}$	7	$9\frac{7}{8}$	$1\frac{7}{8}$	$5\frac{1}{8}$	2
$2\frac{3}{4}$	$17\frac{5}{8}$	$7\frac{3}{8}$	$10\frac{1}{4}$	$1\frac{15}{16}$	$5\frac{7}{16}$	$2\frac{1}{8}$
3	$18\frac{3}{8}$	$7\frac{3}{4}$	$10\frac{5}{8}$	$2\frac{1}{16}$	$5\frac{11}{16}$	$2\frac{1}{4}$

approximate in such cases where the formulas give values which cannot be expressed in even fractions, or give fractional values inconvenient for working figures.

* * *

THE SPOTTER IN THE SHOP.

There may be a better word to express just the same meaning as is expressed by the above title, but if so it is not in the dictionary, and it wouldn't look well in print, and therefore this will have to stand.

We all have met him; he works in every shop from Maine to California. Sometimes he has charge of a department, but he seldom gets as high up as that. He depends more upon his capillary powers to hold a job than he does upon his ability as a workman. If you are a good workman you need never object to his presence in the shop; in fact, it is often of advantage to a good man to have him; but we all detest the principle which allows or compels an employer to use him. He must be regarded by the firm as a necessary evil that cannot be avoided, somewhat similar to the use of cotton waste; you use it, and get all you can out of it, and then chuck it out of sight as soon as you are done with it.

I have worked in shops where there were one or more in every department, and everything said or done went to the office on the "underground" route as soon as it happened. But it does not pay to act as a "spotter" when the old man is not of that kind of stuff as to appreciate your efforts. A good thing of this kind happened at the works of the * * * Company many years ago, which has the merit of being true. One of the men went to the "Professor" with a tale of woe: "There is a man up in room 16 who has a shop down in the basement of his house, and he is experimenting all the time evenings, and he steals all his stock in the shop." "Is that so?" said the "Professor," very much interested. "Well, if you will kindly tell him this for me, that any time he has any trouble stealing all the stock he needs or wants, let me know, and I will see that he has an order for all that he needs." It was a clear case of the spotter getting left.

One more case that came up will show the disadvantages of the "spotter system." A foreman had in his department a large amount of work stowed away under the bench. It was piece work; had been inspected, passed and paid for, and was simply stored there with the knowledge and at the wish of the foreman of the stockroom, who didn't have room to receive it. The spotter didn't know all this and thought it was piece work that was being held back and hadn't been paid for, and was done with the connivance of the foreman. Now, all you boys who read this, and have done contract work, will know just what I mean, so Mr. Spotter puts in his report to the office. The whole matter could have been investigated and settled without any trouble and without the foreman's knowl-

. . . "Caused by breaking off a tap at the bottom of a deep hole."

edge, but instead of that, Mr. Spotter was so sure about the matter that the foreman was called on the carpet to explain. When he had done this to the complete satisfaction of the management, as he turned to leave the office, he couldn't help giving them this shot: "If you had only waited until you got the *next* report from that spotter of yours, it would have saved you all this trouble." A. P. PRESS.

MR. EDITOR: The above was written while recovering from a bad attack of the blues, caused by breaking off a tap at the bottom of a deep, deep hole in a big casting. A. P. P.

* * *

Everyone working at the bench, desk or drafting table likes to have plenty of light, but as the direct glare of sunshine is intolerable, it is generally necessary to screen off the light of windows on the sunny side of the building with shades or ground glass so as to subdue and diffuse the light and thus relieve its intensity. Unfortunately this usually means that a large part of the light is shut out. A scheme which subdues and diffuses the light without greatly reducing its volume was described by Mr. W. J. Thompson at a recent meeting of the Illuminating Engineering Society in New York. He hangs a large sheet of tracing cloth over the windows; the light coming through the tracing cloth is apparently as bright as the direct sunlight but it is diffused, lighting up a room in very much the same manner as an ordinary skylight. He tried the tracing cloth scheme after trying to get proper illumination in other ways, using screens, awnings, shades, etc., but has found that the tracing cloth shades answer the purpose the best of all. The hint is one well worth consideration in the drawing room and is a scheme easily tried as the material is always at hand for a trial. It may be that the simple tracing cloth scheme answers the purpose for which expensive prismatic glass arrangements are often installed; that is, to throw light to the dark side of a room.

MAKING BLANKING DIES TO CUT STOCK ECONOMICALLY.*

C. F. EMERSON.

A most important point for the diemaker to bear in mind in making blanking dies for odd shapes is to lay them out so that the minimum amount of metal will be converted into scrap. In fact, hardly too much stress can be laid upon this one point alone. It is an easy matter to waste a considerable

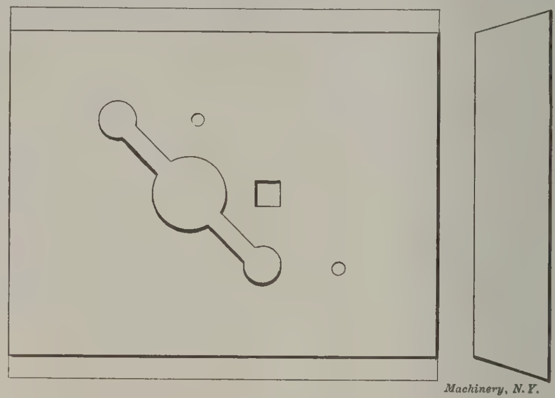


Fig. 1. Plan of Blanking Die.

percentage of the stock by lay-outs which may *appear* to be fairly economical. The diemaker should make a careful study of the most economical relation of blanking cuts to one another and to the stock. It is the object of the following article to point out by actual examples how stock can be saved which might be converted into scrap if the diemaker is not constantly watching out for possible economies. As an illustration, it

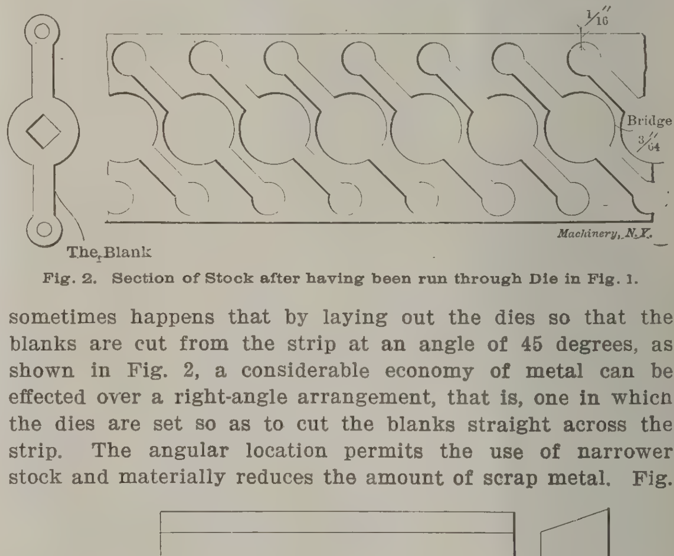


Fig. 2. Section of Stock after having been run through Die in Fig. 1.

sometimes happens that by laying out the dies so that the blanks are cut from the strip at an angle of 45 degrees, as shown in Fig. 2, a considerable economy of metal can be effected over a right-angle arrangement, that is, one in which the dies are set so as to cut the blanks straight across the strip. The angular location permits the use of narrower stock and materially reduces the amount of scrap metal. Fig.

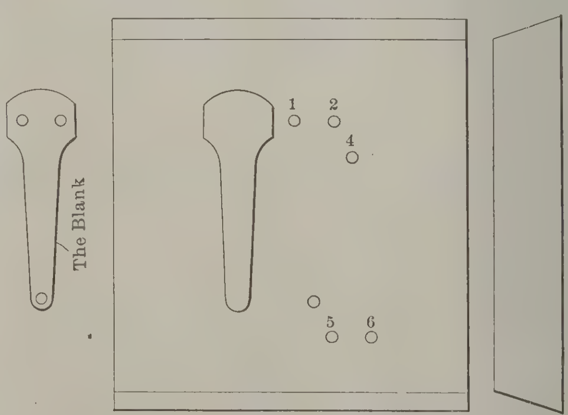


Fig. 3. Another Example of Blanking Die.

1 shows the plan of the die, and needs little or no explanation as the manner in which it is laid out is obvious; the plan of the strip shown in Fig. 2 also clearly shows how the die is laid out.

Another method that is often used to save metal is that shown in Figs. 4 and 5. This method is used where the re-

* This article is a continuation of the articles on die-making by Mr. Emerson, which appeared in the June, 1906, and October, 1906, issues.

quired amount of blanks does not warrant the making of a double blanking die; also when, unavoidably, there is a considerable amount of stock between the blanks after the strip has been run through as shown at *A* in Fig. 4. To save this metal the strip is again run through in a reverse order after the manner shown in Fig. 5, thereby using up as much of the metal as it is possible to do.

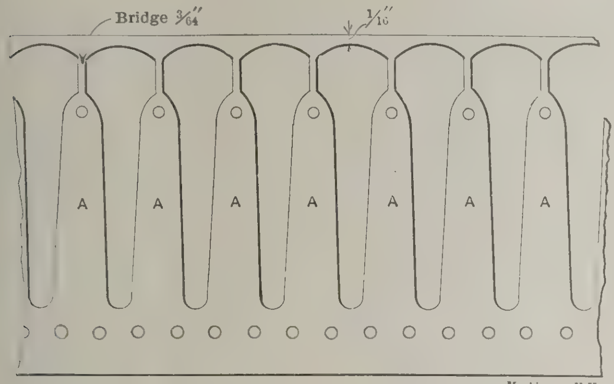


Fig. 4. Stock after having once been run through Die in Fig. 3.

Besides blanking and piercing the blank when running the metal through the first time the holes numbered 4, 5, and 6, Fig. 3, are also pierced. This is done for the reason that when the metal is run through the second time it prevents cutting of "half blanks" by "running in," or, in other words,

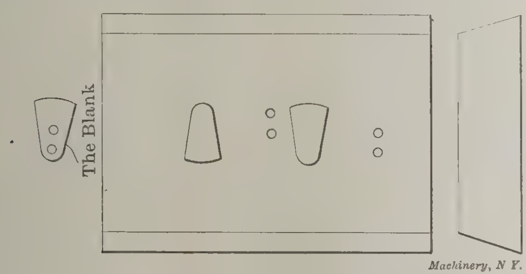


Fig. 6 A Third Example of Blanking Die.

the liability of cutting imperfect blanks by cutting into that part of the metal from which blanks have already been cut. This guiding action is effected by three pilot pins in the blanking punch (not shown) which engage in the three pierced holes, made when the strip was run through the first

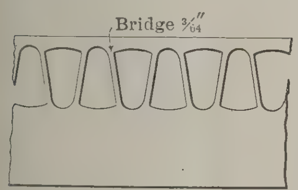


Fig. 7. Stock after having been run through Die in Fig. 6 once.

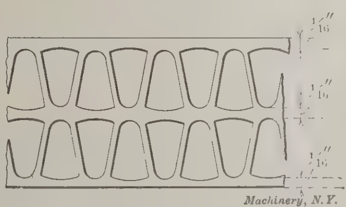


Fig. 8. Stock having twice been run through Die in Fig. 6.

time. The pilot pins engaging with the pierced holes cause the second lot of blanks to be cut centrally with the holes; also to be accurately centered between the portions of stock from which the blanks have already been cut. When this die is in use the metal is run through in the usual way from

holes numbered 1 and 2 in Fig. 3, and the line *B* is the center line of the blanking part of the die. The line *C* is the center line that shows the center of the next blank to be cut and is laid out 53/64 inch from the line *B*. This dimension is fixed by the fact that the widest part of the blank is 25/32 inch and the bridge between the blanks is 3/64 inch, the sum of which equals the distance from center to center of adjacent

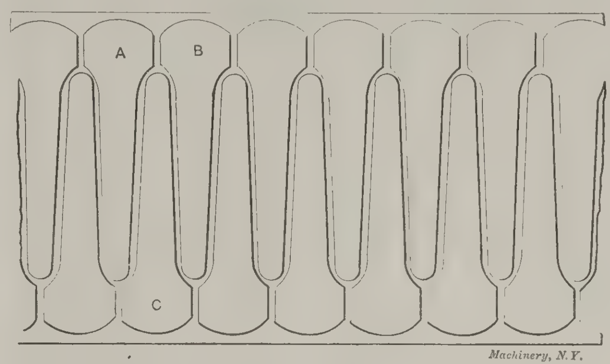


Fig. 5. Stock after having been run through Die in Fig. 3 twice.

blanks. The line *D* is the center line for the blank *C*, Fig. 5, that is cut when the metal is run through the second time, and is made at 0.414 inch or one-half of 53/64 from the line *C*, Fig. 11, inasmuch as the blank is cut centrally between that part of the metal from which the blanks *A* and *B*, Fig. 5, are cut.

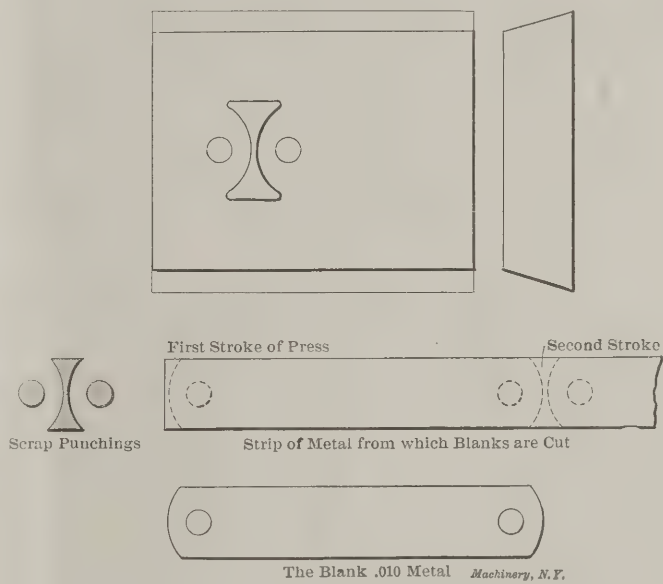


Fig. 10. Blanking Die for Producing Links.

Fig. 6 shows a double die for blanking and piercing brass, producing the shape shown in the sketch at the left; it is laid out so as to save as much of the metal as practically possible without added expense in so far as the operation of blanking and piercing is concerned. By referring to Figs. 7 and 8 it can be seen that the strip of metal from which the blanks are cut is run through a second time for reasons that

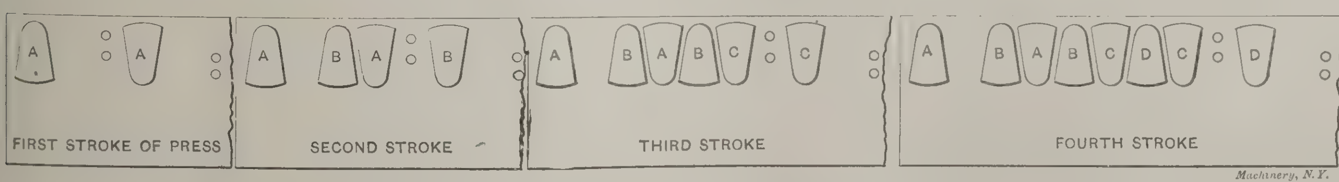


Fig. 9. Appearance of Stock after each successive Stroke of the Press.

right to left until half of the required amount of blanks are cut, after which the piercing punches for the holes are taken out and the metal is run through again and the other half of the required amount of blanks is cut.

In laying out this die which is done after the manner shown in Fig. 11 the line *A* is used as a center line for the piercing

will be given. One reason is that wider metal can be used by doing so which in itself is a saving in so far as the cost of metal is concerned. Wide brass can be bought at a lower price per pound than narrow brass; the other reason is that a strip of metal 1/16 inch wide and as long as the entire length of the strip is saved on every strip that is run through. If

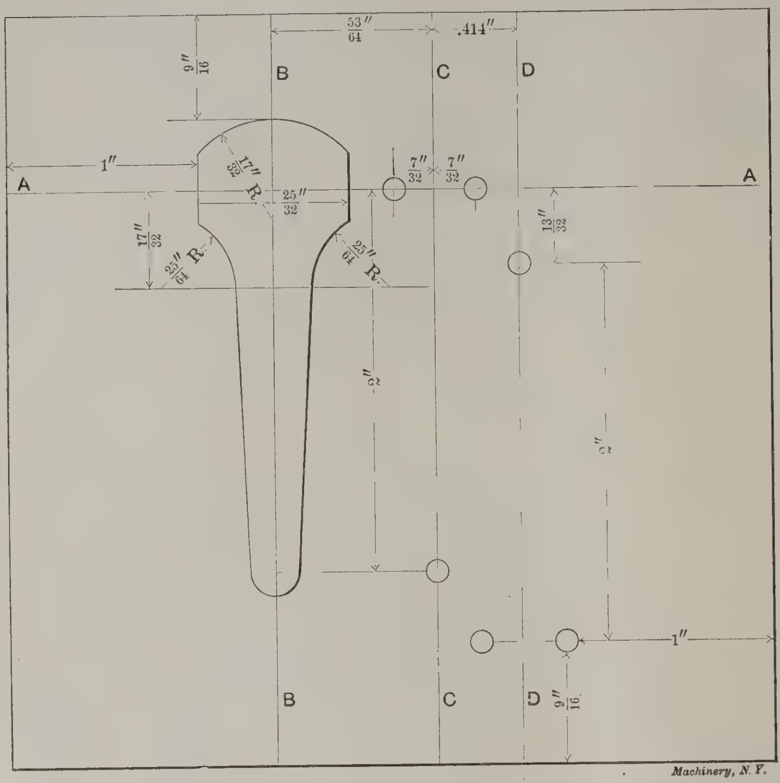


Fig. 11. Layout of Die shown in Fig. 3.

narrow metal were used there would be a waste of ⅛ inch of metal (*i. e.*, 1/16 inch on each side) of every strip run through. But on two strips from which no more blanks can be cut than from the wider strip shown in Fig. 8 there would be a waste of ¼ inch of metal. On the other hand, by using wide metal the waste would be only 3/16 inch, as indicated in the cut. Fig. 12 shows how this die is laid out and should be sufficiently clear to explain itself and thus requires no further words.

To fully understand the manner in which the metal is gradually worked up after each stroke of the press, short sections are shown in Fig. 9. At the first stroke four holes are pierced and two plain blanks—with no holes—*A A* are cut out. At the second stroke there are also four holes pierced and the two blanks *B B* are cut that have the holes pierced at the previous stroke. At the third and fourth strokes the holes begin to match in with each other, as shown so that when the metal is run through it will look like the strip shown in Fig. 7.

It should be borne in mind that four holes are pierced and two blanks are cut at each stroke of the press; also that the

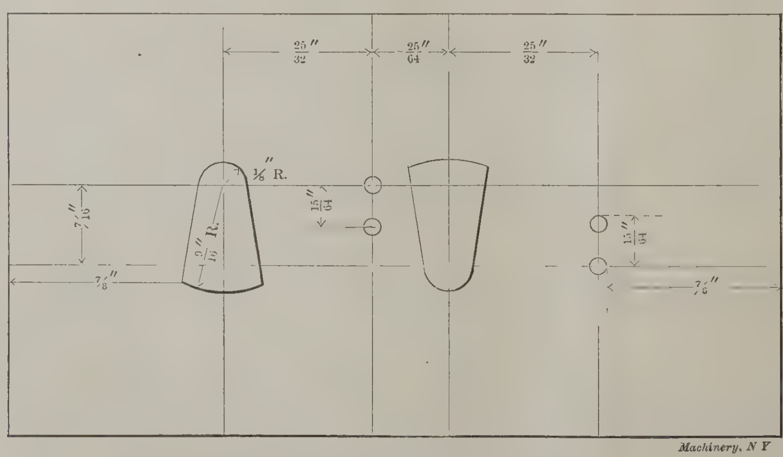


Fig. 12. Layout of Die shown in Fig. 6.

metal is fed after each stroke a distance equal to the distance from the center of *A* to the center of *B*, as indicated in the strip marked "second stroke," Fig. 9, and which is 25/32 inch (see Fig. 12). By way of further explanation it may not be amiss to state that the distances from the center of *A* to *B*, *B* to *C*, *C* to *D*, and *D* to *C*, as shown in the strip marked "fourth stroke" are each 25/64 inch, or half of 25/32 inch.

While the dies shown in Figs. 10 and 13 are commonly known it may not be out of place to say a few words with reference to them as they form an important part in the economical production of sheet metal goods. The first or Fig. 10 shows a die that is used to produce from narrow ribbon a long blank with rounded ends and with a hole pierced in each end. The principal features of this style of die are that there is very little waste of material in the production of the blanks, as will be noted from the sketch of the scrap punchings shown at the left, and the other feature is that by the aid of an adjustable stop, not shown, almost any length of blank can be made without altering or resetting the tools after they have been set up in the press. The working part of the die is laid out a little to the left of the center so as to give sufficient length for the gage plates which are fastened to the die by ¼-inch cap-screws. These gage plates are used to keep the metal in position while it is being fed from right to left as the blanks are cut from the strip.

Fig. 13 is a combination piercing and shearing die and is used for producing the 1-inch square washer shown in the cut. The principal feature of this die is that there is no waste of metal in producing the blank, only, of course, the ¼-inch round punching taken from the center. The strip of metal in

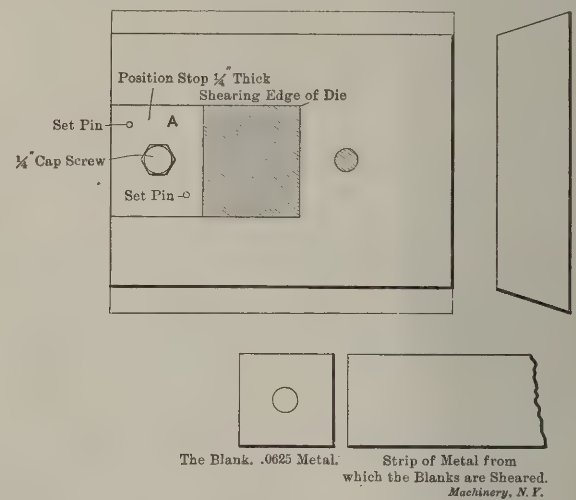


Fig. 13. Blanking Die for Square Washers. Shaded Portions in Die indicate parts punched out from stock

this case can be fed from right to left or front to back as preferred.

* * *

An interesting note in the columns of a contemporary describes a new refrigerator which is "lined with solid white stone mined in the company's own quarries." The statement is made that this stone is almost *ice cold* itself and is therefore specially well qualified to keep the provision chamber at a low temperature and save ice. It is a not uncommon idea that any material which feels cold to the hand must necessarily be a good refrigerating medium. As a matter of fact the colder a piece feels the poorer it is as an insulator, and insulation is largely the secret of refrigerator efficiency, of course. The feeling of cold is due to the conduction of heat away from the hand. The best insulator is that which feels "warm." No simple covering will keep a chunk of ice better than a thick woolen shawl. The shawl has no warmth in itself but is an excellent non-conductor of heat, hence it preserves the ice from melting better than almost any other material so long as it keeps dry.

APPRENTICESHIP EDUCATION.

ENTROPY.

While I have to thank Mr. Strong for his good opinion as expressed in his article (November issue), I thank him more for the opportunity which he seems to give me to sum up the various articles on apprentice education which I have written from time to time under various pen-names. I have tried in the past to present my plan a bit here and a bit there, seeking to interest as many as possible and knowing that the very men whom I wish to reach are the busiest and have the least tendency to begin to read long and learned articles. While the subject is more or less of a hobby with me I am still sufficiently disinterested so that I can take any suggestions in the spirit in which they are sent. My work in this line is not for my personal gain at all, for while I would like to be in at the start of any school or shop organization I do not care to follow it up for a livelihood. With this in mind as well as to persuade Mr. Strong that my plan as a whole covers his point I will put the whole thing as concisely as possible. My plan involves a shop and revolves about the shop as its central idea. The shop must be a commercial shop—absolutely must. Preferably it should make a large enough range of work so that it may train the boy with mechanical ability and incapacity for fine work as well as the boy to whom close measurement is a pleasure.

Then there must be a school in which should be taught those things which are of *direct* use to a machinist, foreman, or master mechanic. No others. This must be religiously adhered to. Otherwise the result will be that some ambitious teacher will make a third-grade engineering school of it. The control of the school must be from the shop to secure its subordination. The division of time should, for commercial reasons, be made such that half the boys are running machine tools all the time. The other half should be divided between school-room work, drafting, and hand work. The length of time which the boys stay in either division should not be over a week.

Pay.

For any man to be content he must feel that he is making a good thing of it. You can pay a man in money or in something which he can reasonably expect to turn into money later. With boys of the class that we must expect to take, money is the best with which to appeal. If they are to be paid in money it must be an equitable payment for what is done. As Mr. Strong hints, when a boy goes into a shop he is enthusiastic and works around lively. As soon as he gets so that he can do something commercially well he finds that he is kept in it as long as he will stand it, without increase of pay. He does not feel that he is being treated right if he does a man's work without a man's pay. His employer tells him that it has cost him good money to teach the apprentice to do this work. If the apprentice has any head for mathematics at all he can figure pretty close to what it has cost the firm to have the foreman stop and make fun of him a few times and show him about once how to do a little job. No wonder he gets listless.

Instead of paying by the hour, pay by the piece. For finished work done acceptably pay a little less than the journeyman's rate to cover increased length of time the apprentice ties up a machine. Charge the boy a certain amount for teaching him each step of his progress. Have him pay cash or work it out by keeping at this one style of job after he has gotten so he can work a commercially acceptable job. If he wants more money to spend or to live on let him work on this same job till he has earned enough to satisfy him. The average boy would stay on the job till he was really pretty expert at it, and I think be very content. The employer would know just how he was coming out at the end of the term of apprenticeship. If a shop is not already on a piecework or premium basis it would mean quite a little work to arrange for the apprentices so that they would get a consistent course and have their piecework or premium rates fair to both sides.

Class of Boys to become Apprentices.

The present and ever present need of the shops is for skilled workmen who can work with judgment. If such boys as now go to technical schools are selected they will become good machinists, but they will not be content to stay machinists long. They will want to and will go higher. It is apart from my purpose to discuss the relative merits of engineers trained in this way and those trained in technical institutions. But this seems sure to me that for an apprentice system to be successful from a manufacturer's point of view its recruits have to be from a stage in life where $15 or $18 a week looks big. To such boys the possibility that if they are diligent they may become leading hands or foremen, or that occasionally one may rise to be a master mechanic, a superintendent, will be enough to attract them. The examination then for admission to such a school should set an upper limit above which a candidate should not pass, as well as a lower limit, which he must equal.

Foremen and Teachers.

To ask the regular shop foreman to take apprentices under his charge and give them the attention they need is an injustice to him. His business is to produce work, not teach. He has to earn his salary if he does his legitimate work. More than that, it is rarely the case that a foreman who is good with the boys is good for much as a foreman. While school-room teaching in addition to the present loose method in the shop would be better than nothing I hope no one will think that I prefer the makeshift which I suggested in the August issue to this main plan. In a shop I would suggest a room partitioned off, as they do in Lynn, from the rest of the shop, but I should keep the boys there full two years of their course in contact only with the best of leading workmen.

These instructors should be men of experience but they should be young enough to have active interest in their work and they should know that their future pay will depend exclusively on results obtained. The instructor in machine work should be a good clean-cut mechanic whose experience and judgment renders him capable of all grades of work, and who can take hold and show the boys. The instructor in the school room should be some young man, say a draftsman with technical education who has been out long enough to have forgotten all his calculus and most of his trigonometry, a man who knows what methods will give solutions of everyday problems with the least mental effort. No teacher of the usual educational type need apply. No one will do who cannot pick up out of his memory a lot of really useful problems.

How a Small Shop can Afford to Start a School.

I should say that a shop with a dozen boys is the lowest number possible. More will be better. With so few boys the shop instructor might do some work himself at the lathe or bench though I mistrust that it would pay to have him right around the boys all the time, even with so small a number. For equipment give them tools already in use in the shop. Not the most antiquated in design but something modern. If badly worn let the best of the boys repair them. Have them keep the tools up in good shape too. The reason for putting the boys all in one room for so long a time is this. Almost all shops have a pacer, or a man who sets the gait at which the rest go. Such a man makes it impossible to get an apprentice to set any faster pace. What is wanted is men who follow no pace but their own. They are wanted badly enough so that they can command their own price and their own hours within reason. If the boys do not know anybody else's pace and are paid piece or premium rates they will, as they grow expert, tend to set a pace which will make them valuable to a point of healthful independence.

Cost.

This is not a philanthropic scheme at all. Unless it pays it neither will be done nor ought to be done. Unless boys can be held by nothing more than their own self-interest they ought not to be held. The old-time apprentice system said to a boy: "Come in and I will teach you a trade. But you must put yourself entirely in my power, be my slave for a term of years." In itself it was an admission that when the boy found out how he was to be treated he would quit if he could. Unless a contract is mutually agreeable it

is a poor contract for either party in the long run. Under my plan we will say to a boy: "Come in and for a certain price we will teach you to do a certain job. We will guarantee you work at fair pay on that job long enough so that you can afford to pay our price. Then if you want to learn another step of the trade we will teach it to you and you shall pay us for doing it. You may leave any time that you think you have learned enough. If you come in you must attend our school and get what you can out of it." Under this plan it is perfectly feasible to so set piece work or premium rates that the proprietor may know pretty closely where he will come out at the end of the year. He ought to come out a trifle ahead. The boy's self interest will keep him working on a job long enough to get some money ahead which will insure his dexterity. His self-interest will make him take up the next job as soon as he can afford it and will make him learn as fast as he can so that he can get to making money. His self-interest will keep him faithful in school for just the same reason that men are faithful to their correspondence school work.

The thing which yet remains to be accomplished before anything can be started is to persuade manufacturers that for their own safety in the future the country needs skilled, intelligent, native workmen; men who can stand on their own bottom and do the work which is needed to keep this country commercially ahead of the world, and men who need hide behind no organization to command the respect of their employers, and men who can and will bring skill and judgment to their work so that they may command compensation beyond the dream of any organization.

* * *

WEIGHT OF TIN PLATES.

The accompanying table by Mr. Horace Chrisman, East Pittsburg, Pa., contains some very useful data on tin plates. It includes the different denominations of tin plates and the corresponding number of the United States standard gage; also the nearest Brown & Sharpe gages and the actual thickness in decimals of an inch. The thickness of tin plate varies

WEIGHT OF TIN PLATE PER SQUARE FOOT.

Trade Designation of Gage.	Fraction of a Pound Tin Plate.	Ozs. Tin Plate	U. S. Standard Gage.	Nearest B. & S. Gage.	Thickness in Decimal Parts of an Inch.
IC	0.5	8.0	30*	28*	0.0125*
IX	0.625	10.0	28	26	0.015625
IXX	0.711	11.37	26½	24	0.018930
IXXX	0.8	12.8	25½	24	0.020300
IXXXX	0.9	14.4	25	23	0.021875
IXXXXX	1.0	16.0	24	22	0.02500
DC	0.64	10.25	28	26	0.015025
DX	0.83	13.25	25½	24	0.020300
DXX	0.97	15.5	24	22	0.02500
DXXX	1.11	17.8	23	21	0.028125
DXXXX	1.25	20.0	22	20	0.031250

* Thickness of black sheet before tinning.

according to the coating of tin retained on the surface of the sheet. About two or three numbers of Brown & Sharpe gage should be added to the above columns marked with the asterisk to get the thickness of tinned plates.

* * *

There is a decided difference between a true mathematician and one who is "quick at figures." The true mathematician is a logician; he deducts certain facts and relations by a course of reasoning and proves them by calculation. If the figures do not prove his deduction he is more likely to look for the fault in the calculation than in his course of reasoning, for its very logic denies the possibility of error. The one quick at figures must, of course, be something of a logician but there is the difference that the first uses calculations as the means to prove a logical deduction, while the other always uses concrete quantities to get a definite result, and with, perhaps, only a dim idea of the mathematical principles involved. The use of a general expression to cover all possible cases of a given problem does not appeal to the "figurer" but it is just what the mathematician always seeks.

TEMPERING HOLLOW MILLS AND OTHER TOOLS.

J. F. SALLOWS.

The art of tempering high-class tools is understood by few mechanics; the majority of them know little or nothing whatever about tempering even so common a tool as a cold chisel. They think that standard sized tools bought in large quantities by factories throughout the country, which are stamped "B. & S.," "P. & W.," or some other well-known firm name, must be O. K., and often they would give a great deal to know just how to temper tools as well as these are tempered. This blind faith sometimes is the cause of amusing incidents. I have known a machine shop foreman to send a number of machine steel pieces into the smith to be annealed so they could be drilled. Upon investigation it was found that a new drill was too soft to drill anything except lead or pine, but after hardening, the pieces referred to were easily drilled. The fact of the matter is that the foremen and men under them often take for granted that because a drill is a twist drill and bought from a well-known concern it must, of course, be perfect, but if it were made in the shop where the work was being done and proved faulty they would very likely blame the man who did the tempering—even if it was done as it should be.

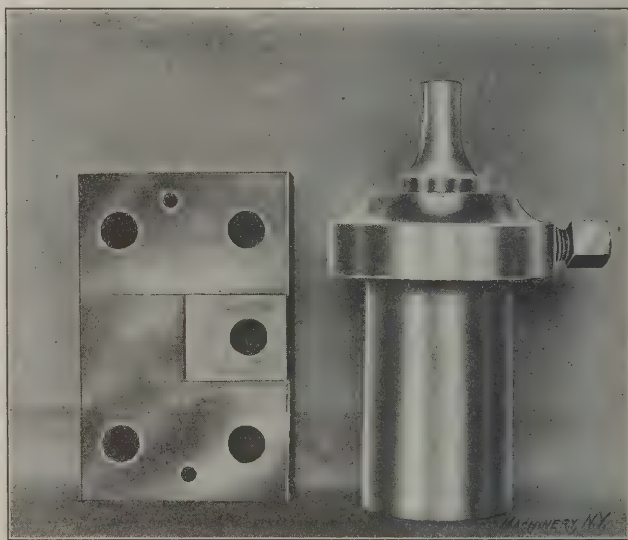


Fig. 1. Punch and Die having a Good Record. Hardened, but not Drawn.

In my experience of twenty-seven years on nearly all kinds of tools I find that each and every kind of tool has to be tempered in a way that suits its individual peculiarities and the class of work which it is intended to do. For example, I would not temper a tool for cutting brass the same as one for cutting machine steel, but nothing is more common than to find a smith tempering all lathe tools alike. This lack of discrimination is the cause of a great deal of trouble in all large plants. The man about to use the tool does not inform the smith who tempers it what the tool is required to do. Therefore, it is impossible to give general satisfaction. The smith who does the tempering blames the steel, and the one using the tool blames the smith and the tempering. As an example of my system I will write at this time about tempering hollow mills and explain what I claim to be the only correct method of tempering them to give satisfaction.

I cannot explain—nor can anyone else satisfactorily—why it is necessary to heat a tool up to a high lemon color and quench it off in cold water, then clean it all over, polish, rub, and perhaps spend ten hours time on what could be done in two hours. This may seem like a radical statement, but it will not appear so when I can prove to you that I can temper a three-inch mill and have it ready for work in twenty minutes. I have seen large tools hardened and put on the bench to be cleaned all over before being drawn to a light or dark straw as the case may require, but I never could find out whether the color was that of pea straw or rye straw (we can, by the way, draw machine steel to a nice straw). I have seen three punches tempered and drawn to the same color;

one was too soft to be of any use and the other two broke similar to cast iron. The difference in action was due to the way in which they were heated. Drawing a tool carefully to color cannot let you out if you do not watch your hardening heat. But, to return to the tools on the bench to be cleaned; when the man was ready to do the cleaning he found instead of having six tools he had eighteen parts of tools. The blame for this catastrophe was laid to the steel when the workman himself was at fault for going at a job he knew nothing about; before he was ready to relieve the so-called

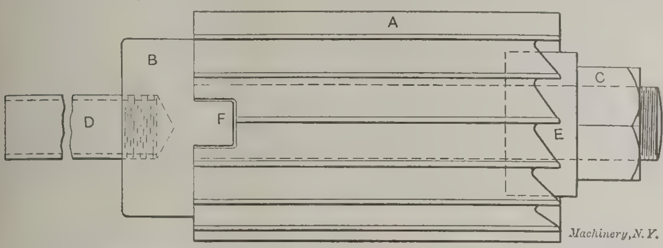


Fig. 2. Mandrel and Handle with Hollow Mill Mounted for Hardening.

internal strains they had relieved themselves, but why have internal strains to relieve? If the tempering smith will temper tools as I am about to explain he will have no internal strains to bother with, and the workman will have a milling cutter that will do more work and give better satisfaction than any internal-strain-relieved straw-colored tool that was ever tempered by any smith in any shop. As an example the accompanying halftone, Fig. 1, shows a 7/16-inch punch and die that has punched 100,000 holes in ¼-inch machine steel, or the equivalent of 25,000 lineal inches. The punch and die are still at work; it is interesting to know that they were never drawn to a straw color and I am sure that neither is troubled with any internal strains.

A smith doing tempering should do no welding and should, when not employed at tool work, be at some kind of work that can always be done at a low heat; then by following the rules laid down here he can become an expert on hollow mills as well as other tools. My equipment and method are as follows:

Fig. 2 shows a hollow mill *A*, mounted on a stud or mandrel *B* which is made of machine steel to fit the mill and

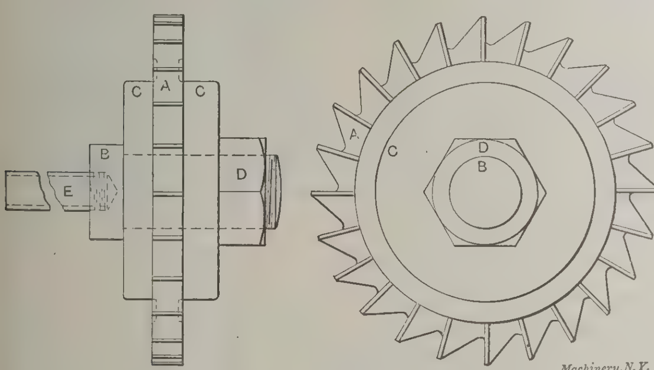


Fig. 3. Rig for Hardening Side Milling Cutters.

provided with a washer *E* and nut *C*. The stud must closely fit in the slot of the hollow mill, as shown at *F*. The end of the stud opposite the threaded end is tapped out with a pipe tap for the pipe handle *D*, which is used for handling the work when heating and hardening, the handle being a half-inch pipe about 24 inches long. This same pipe handle will do for a large variety of different sized studs. Of course if a furnace is provided for heating tools of this kind a pipe handle will not be necessary, but if only an ordinary forge is used for tempering and hardening this scheme is desirable. It is quite necessary to have a good mill file at hand to test the hardness of tools, for sometimes in my experience I have known the toolmakers to send out tools made from machine steel, and insist on having them hardened and tempered. In such cases the file is the only method of showing the toolroom foreman his mistake. I have experienced this trouble more than once and know whereof I speak.

Build a fire in the tempering forge with charcoal lumps about the size of a hen's egg. Place the hollow mill assembled as shown in Fig. 2 on the fire and cover with charcoal; shut off the blast and let the tool heat with the charcoal until it has reached a nice bright heat, then take out, dip into a solution of salt and water in the proportion of about ½ pint of salt to 2 gallons of water. Be sure that the salt is well dissolved. Do not let the milling cutter cool in the water, but when the red is all gone remove from the water, let the tool dry and plunge in a crock of fish-oil. Leave the cutter there until cold enough to handle, then take out, remove the nut and washer, take the cutter off and send it to the toolroom to be put to work. Perhaps the smith will not be successful with the first one hardened and tempered by this method but a few trials will lead to success.

When tempering milling cutters of the type shown in Fig. 3 the smith must have a small, high fire and put on the blast lightly, turning the tool constantly until ready to dip. Then dip in salt water the same as directed for the hollow mill. The result is no warping or cracking and no internal strains in any cutters tempered in this manner, and they will stand more hard work than if tempered in any other way. In explanation of the rig used for tempering the milling cutter shown in Fig. 3, *A* is the cutter, *B* the stud, *C* the washers, *D* the nut, *E* the pipe for handling. The washers protect the body of the cutter from heating and only the teeth are heated to the hardening temperature. The consequence is that there is no necessity for drawing the temper of the body of the cutter inasmuch as it has never been heated to the hardening heat; consequently it is always left soft.

A serious trouble with heating tools to remove internal strains aside from those already mentioned is shown in the case of a solid reamer. Suppose a solid reamer is held over the fire to remove internal strains. The result is that the thin edges which are the cutting parts are heated much quicker than the internal parts, and are softened, so much, perhaps, as to render the tool useless, but by hardening as just directed and taking the reamer out of the water before it is cool and putting it into fish-oil its toughness is preserved and at the same time it does not get any softer than it was when it was removed from the water.

[The method recommended by Mr. Sallows, of course, is radically different from general practice, although strictly analogous to the common practice of hardening and tempering chipping chisels and similar tools. If a milling cutter, hollow mill or any other expensive tool can be successfully hardened on the points of the teeth only we are sure that the practice is one to be recommended for several obvious reasons. If there are serious objections let us hear what they are.—EDITOR.]

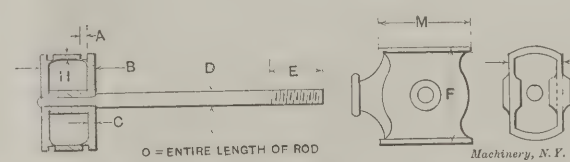
* * *

SLIDE VALVE ENGINE PROPORTIONS.

The accompanying tables on plain slide valve engine proportions, including cylinders, connecting-rods, valves, pistons and piston-rods, crossheads, crankshafts, crankpins, crank-disks and eccentrics, were compiled by Mr. C. R. McGahey, while superintendent of Lombard Iron Works, Augusta, Ga.

PISTON, PISTON-ROD AND CROSSHEAD.

O = entire length of piston-rod.

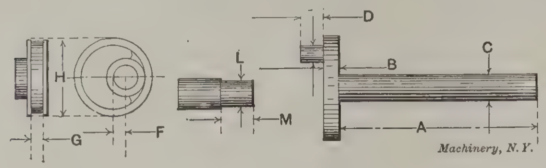


Cylinder.	*A*	*B*	*C*	*D*	*E*	*M*	*N*	*H*	*O*	*F*
7 x 10	⅜	3	⅜	1⅜	3⅝	7¾	4	⅜	23⅝	8
8 x 10	⅜	3	⅜	1⅜	3⅝	7¾	4	⅜	23⅝	8
9 x 12	½	3½	½	1½	5	9½	5	½	28⅝	10
10 x 12	½	3½	½	1½	5	9½	5	½	28⅝	10
11 x 14	⅝	3⅞	½	1¾	5½	10½	5½	½	33	11¼
12 x 14	⅝	3⅞	½	1¾	5½	10½	5½	½	33	11¼

We are assured by Mr. McGahey that the tables of dimensions represent the most advanced and best known practice with this type of steam engine. The tables are of the same order as the dimensions of equal section and concentric piston rings contributed by Mr. McGahey in the February (1906) issue.

ECCENTRIC, CRANKSHAFT AND CRANK-PIN.

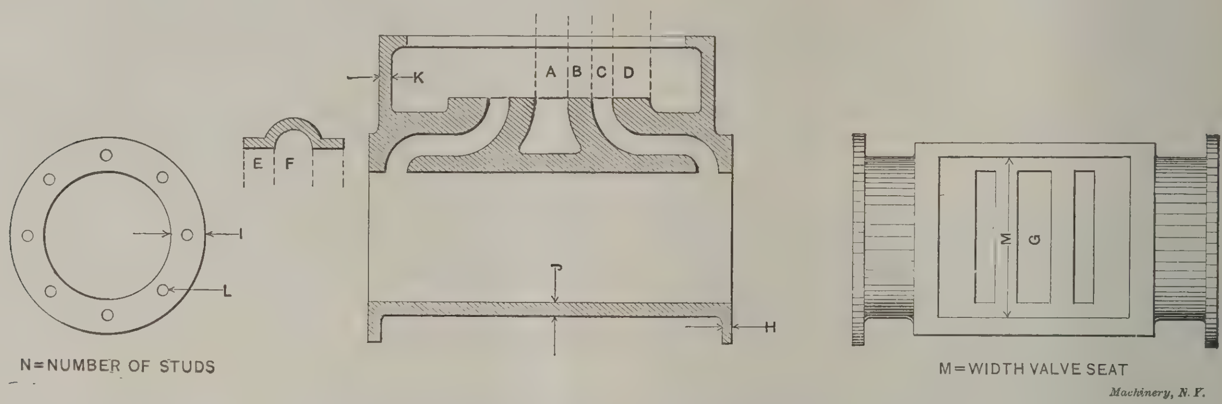
I = travel of valve. J = width main bearing. K = width main bearing pillow block.



Cylinder.	A	B	C	D	E	F	G	H	I	J	K	L	M
7 x 10	42	$2\frac{3}{8}$	$3\frac{3}{8}''$	$2\frac{3}{4}$	$1\frac{15}{16}$	1	$1\frac{1}{4}$	$6\frac{1}{4}$	2	7	$8\frac{3}{4}$	$1\frac{13}{16}$	$2\frac{1}{8}$
8 x 10	42	$2\frac{3}{8}$	$3\frac{3}{8}$	$2\frac{3}{4}$	$1\frac{15}{16}$	1	$1\frac{1}{4}$	$6\frac{1}{4}$	2	7	$8\frac{3}{4}$	$1\frac{13}{16}$	$2\frac{1}{8}$
9 x 12	54	3	$4\frac{3}{8}$	$3\frac{1}{2}$	$2\frac{1}{2}$	$1\frac{1}{4}$	$1\frac{3}{4}$	8	$2\frac{1}{2}$	$8\frac{1}{2}$	10	$2\frac{3}{8}$	$2\frac{7}{8}$
10 x 12	54	3	$4\frac{3}{8}$	$3\frac{1}{2}$	$2\frac{1}{2}$	$1\frac{1}{4}$	$1\frac{3}{4}$	8	$2\frac{1}{2}$	$8\frac{1}{2}$	10	$2\frac{3}{8}$	$2\frac{7}{8}$
11 x 14	57	$3\frac{3}{8}$	$5\frac{3}{8}$	$3\frac{3}{4}$	$2\frac{11}{16}$	$1\frac{3}{8}$	2	$8\frac{1}{2}$	$2\frac{3}{4}$	10	$12\frac{1}{2}$	$2\frac{9}{16}$	$3\frac{1}{8}$
12 x 14	57	$3\frac{3}{8}$	$5\frac{3}{8}$	$3\frac{3}{4}$	$2\frac{11}{16}$	$1\frac{3}{8}$	2	$8\frac{1}{2}$	$2\frac{3}{4}$	10	$12\frac{1}{2}$	$2\frac{9}{16}$	$3\frac{1}{8}$

the cutting edges, which are further apart to insure that the width of the land would be equal in all cases. That this is impracticable when fluting reamers in any large quantities is easily apprehended, as it would necessitate raising or lowering the milling machine table for each flute being cut. In the *Zeitschrift für Werkzeugmaschinen und Werkzeuge*, a method is shown employed by the large machine tool firm of Ludwig Loewe & Co., Berlin, Germany. The principle of this method is clearly shown in the accompanying cut. A formed cutter, eccentrically relieved, is employed which, instead of forming only the flutes, forms the actual land of the reamer, thus insuring that every land becomes equally wide with the others. The depth of the flute is determined by the depth of the portion of the cutter in front of the cutting edge of the reamer and it is easily seen that all the flutes will be equally deep.

That this method will be more expensive than the one commonly employed, in which the lands are permitted to become wide or narrow according to the amount the flutes are broken up, is evident, but it cannot be disputed that the general appearance of the reamer will be greatly improved. The greater expense in making reamers in this manner will depend on two factors. In the first place, the eccentrically relieved cutter will cost more to produce than the ordinary fluting cutter. In the second place, the cutting speed cannot be as high with a cutter of this description as it could be with an ordinary milling cutter. On the other hand, it is possible not only to gain the advantages mentioned above in regard to width of land and depth of flute, but incidentally there is also gained the possibility of giving to the flute a more correct form to answer the requirements of strength as well as chip room, which are often by necessity overlooked on account of the straight sides forming the flutes which are necessary to adopt when using the ordinary straight-sided fluting cutter, with milling cutter teeth of the common shape. While it cannot be expected that this method will be used to any great extent on account of its drawbacks from a commercial point of view, it is ingenious and well worth attention.

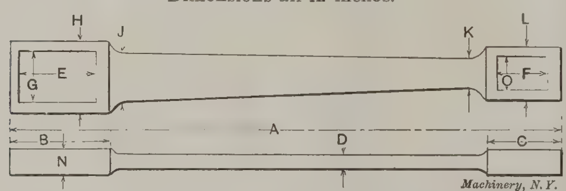


CYLINDER, VALVE AND VALVE SEAT.

Diameter Cylinder.	Length of Stroke.	A	B	C	D	E	F	G	H	I	J	K	L	M	N
7	10	$1\frac{1}{16}$	$\frac{9}{16}$	$\frac{5}{8}$	$1\frac{1}{8}$	$1\frac{11}{32}$	$1\frac{7}{8}$	$5\frac{7}{8}$	$\frac{7}{8}$	$2\frac{1}{4}$	$\frac{11}{16}$	$\frac{5}{8}$	$\frac{3}{4}$	$6\frac{1}{2}$	6
8	10	$1\frac{1}{16}$	$\frac{9}{16}$	$\frac{5}{8}$	$1\frac{1}{8}$	$1\frac{11}{32}$	$1\frac{7}{8}$	$5\frac{7}{8}$	$\frac{7}{8}$	$2\frac{1}{4}$	$\frac{11}{16}$	$\frac{5}{8}$	$\frac{3}{4}$	$6\frac{1}{2}$	6
9	12	$1\frac{3}{8}$	$\frac{5}{8}$	$\frac{23}{32}$	$1\frac{7}{32}$	$1\frac{5}{8}$	$2\frac{1}{4}$	$8\frac{3}{4}$	$\frac{7}{8}$	$2\frac{3}{4}$	$\frac{3}{4}$	$\frac{5}{8}$	$\frac{3}{4}$	$8\frac{3}{4}$	8
10	12	$1\frac{3}{8}$	$\frac{5}{8}$	$\frac{23}{32}$	$1\frac{7}{32}$	$1\frac{5}{8}$	$2\frac{1}{4}$	$8\frac{3}{4}$	$\frac{7}{8}$	$2\frac{3}{4}$	$\frac{3}{4}$	$\frac{5}{8}$	$\frac{3}{4}$	$8\frac{3}{4}$	8
11	14	$1\frac{3}{4}$	$\frac{11}{16}$	$\frac{3}{4}$	$1\frac{1}{2}$	$1\frac{13}{16}$	$2\frac{3}{4}$	$9\frac{5}{8}$	$\frac{15}{16}$	3	$\frac{13}{16}$	$\frac{11}{16}$	$\frac{3}{4}$	$10\frac{3}{8}$	10
12	14	$1\frac{3}{4}$	$\frac{11}{16}$	$\frac{3}{4}$	$1\frac{1}{2}$	$1\frac{13}{16}$	$2\frac{3}{4}$	$9\frac{5}{8}$	$\frac{15}{16}$	3	$\frac{13}{16}$	$\frac{11}{16}$	$\frac{3}{4}$	$10\frac{3}{8}$	10

FORGED STEEL CONNECTING-ROD.

Dimensions all in inches.

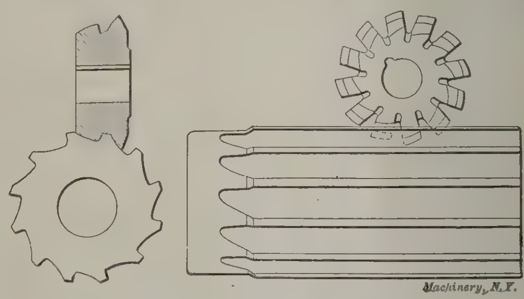


Cylinder.	A	B	C	D	E	F	G	H	J	K	L	N	O
7 x 10	$31\frac{1}{8}$	$6\frac{5}{8}$	$5\frac{1}{8}$	$\frac{3}{4}$	$5\frac{1}{8}$	$3\frac{5}{8}$	$3\frac{1}{8}$	$4\frac{5}{8}$	$3\frac{1}{4}$	3	$1\frac{3}{4}$	$1\frac{3}{8}$	$3\frac{5}{8}$
8 x 10	$31\frac{1}{8}$	$6\frac{5}{8}$	$5\frac{1}{8}$	$\frac{3}{4}$	$5\frac{1}{8}$	$3\frac{5}{8}$	$3\frac{1}{8}$	$4\frac{5}{8}$	$3\frac{1}{4}$	3	$1\frac{3}{4}$	$1\frac{3}{8}$	$3\frac{5}{8}$
9 x 12	$36\frac{3}{4}$	$7\frac{1}{8}$	6	$\frac{7}{8}$	$5\frac{1}{2}$	$4\frac{1}{4}$	$3\frac{3}{8}$	5	4	$3\frac{1}{8}$	$2\frac{1}{8}$	$1\frac{5}{8}$	$4\frac{1}{4}$
10 x 12	$36\frac{3}{4}$	$7\frac{1}{8}$	6	$\frac{7}{8}$	$5\frac{1}{2}$	$4\frac{1}{4}$	$3\frac{3}{8}$	5	4	$3\frac{1}{8}$	$2\frac{1}{8}$	$1\frac{5}{8}$	$4\frac{1}{4}$
11 x 14	43	8	$6\frac{5}{8}$	$1\frac{1}{8}$	$6\frac{1}{4}$	$4\frac{7}{8}$	$3\frac{3}{4}$	$5\frac{1}{2}$	$4\frac{5}{16}$	4	$2\frac{5}{8}$	$1\frac{7}{8}$	$4\frac{7}{8}$
12 x 14	43	8	$6\frac{5}{8}$	$1\frac{1}{8}$	$6\frac{1}{4}$	$4\frac{7}{8}$	$3\frac{3}{4}$	$5\frac{1}{2}$	$4\frac{5}{16}$	4	$2\frac{5}{8}$	$1\frac{7}{8}$	$4\frac{7}{8}$

* * *

NEW METHOD OF MILLING THE FLUTES OF REAMERS.

In milling the flutes of reamers it is customary to mill them so that the cutting edges will not come an equal distance from one another. This prevents chattering and permits the use of an even number of flutes. The difficulties encountered in milling the flutes on unequal distances, or breaking up the flutes as it is commonly termed in the shop, are that if all the grooves are milled to the same depth the remaining land evidently will be wider in the case where the distance from cutting edge to cutting edge is larger than it will be in the case where this distance is smaller. To overcome this it would, of course, be possible to mill the flutes deeper between

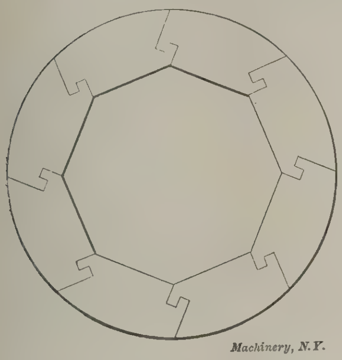


German Method of Fluting Reamers.

ITEMS OF MECHANICAL INTEREST.

WOODEN LOCK-JOINT COLUMN.

The Woodworker illustrates a method of making column joints which, on account of its ingenious interlocking device, may deserve the attention and interest of others than woodworkers. As seen from the cut, the finished column constitutes a solid, which cannot be disintegrated by any other means than by sliding one of the interlocking parts out in a longitudinal direction. Evidently it cannot be assembled in any other way, either, than by sliding in the last section from the end.



Method of Making a Wooden Lock-joint Column.

PAPER MILK BOTTLE.

Here is an item of mechanical interest for this page quite out of the usual run, but it is nevertheless of much general interest. It is a paper milk bottle designed to replace the glass bottles now generally used. The paper bottle is claimed to have the advantages of less cost, much less weight, greater cleanliness, no expense for washing and return transportation. When it is known that the ordinary glass milk bottle weighs as much as the milk, *i. e.*, two pounds for a quart bottle it at once becomes apparent that the bottles represent half the dead weight when milk is transported in this shape. The dead weight loss is still greater in that the bottles have to be returned. The paper bottle is designed to be used only once and then thrown away, thus saving all cost of returned transportation, and also washing. The bottles are made in three sizes, quarts, pints and half-pints, the material used being three-ply spruce wood fiber paper rolled into a frustrum of a cone. The bottoms are secured by an ingenious lock, and it is claimed that the inverted bottle will support a load of 200 pounds without collapse. The lid is an inverted cup fitted into the lumen of the bottle and having a contact with the sides of ½ inch. Removal is facilitated by four tabs which permit of finger hold. The whole bottle including the bottom and top is covered with a coat of paraffine which more or less completely impregnates the paper. The cone shape facilitates packing, as they may be assembled in "nests," putting one inside another and thus saving much space. An idea of the saving of weight may be gained from the fact that 150,000 paper bottles may be shipped in an ordinary freight car, the weight being only about six or eight ounces each as against about thirty-two ounces with glass.

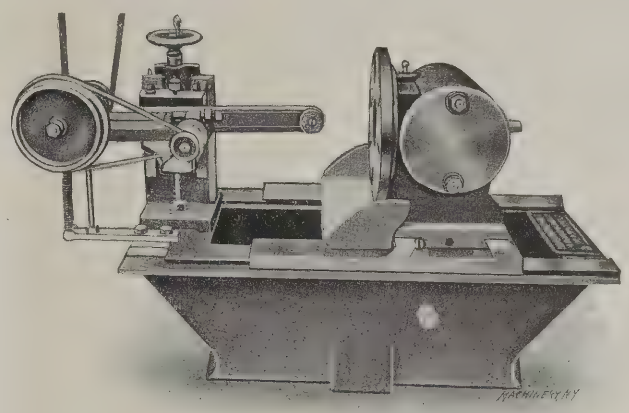
Paper Milk Bottle.

SQUARE HOLE GRINDING MACHINE.

An unusual machine for an unusual operation—the grinding of square holes, as indicated in the title—has been designed and is being put on the market by C. W. Burton, Griffiths & Co., Ludgate Square, Ludgate Hill, London, E. C. The special operation for which the machine is needed is that of finishing square holes in the hardened gears used in automobile speed transmission cases; it is intended to do away with the slow and costly lapping operation which has hitherto been resorted to for truing up these surfaces in getting rid of the distortion resulting from the hardening operation to which they are subjected. It is also applicable to the finishing of dies of various kinds and other hardened parts having internal flat surfaces difficult to reach by ordinary means.

The work is fastened on the faceplate at the right of the machine. This faceplate, which is 12 inches in diameter, is mounted on a spindle having a 4-inch diameter hole to permit gears or pieces with projecting bosses to enter the end of spindle and thus make the clamping more convenient. In the case of the plain machine this faceplate has indexing notches and is provided with a locking lever. A cross slide operated by a screw and hand wheel, graduated to 0.001 inch, gives the necessary adjustments for feeding. This machine is adapted for grinding parallel holes only. The universal machine, in addition to grinding parallel holes, will grind tapered ones, the work carrier having an angular adjustment both above and below the horizontal axis and a circular movement around its base. Where required the machine can be furnished with self-acting travel of the work carriage on the bed at extra cost.

The vital feature of the machine is the method of supporting and driving the emery wheel. This wheel, of small enough diameter to enter the square hole which it is desired to finish, is mounted on a transverse axis at the outer end of the long bar shown. The short spindle which carries the wheel at one end is mounted on ball bearings set as far apart as possible and carries a grooved pulley at the opposite extremity. An endless belt, made from a leather ring rolled until the edges have been rounded, is used to drive this short spindle and the wheel fastened to it. As will be readily understood from the cut, the spindle, emery wheel, belt and bar are all of such proportions that they can enter bodily the hole which is to be finished. In order that the maximum of stiffness may be obtained in the support of the grinding wheel, it is recommended that a separate bar be used for each size of hole, with separate spindle and wheel for each. The price of one bar and its attachments is included with the machine.



Square Hole Grinding Machine.

A small speed multiplying countershaft is used to transmit the motion from the countershaft belt to the wheel. The bar is carried on a vertical slide adjustable by the handwheel shown. The countershaft is supported by a mounted arm with spring tension so as to prevent vibration in the driving belt from affecting the emery wheel bar as it would be liable to do if attached rigidly to it. This precaution, in addition to the use of an endless belt for driving the wheel spindle, assures the freedom from jar and vibration necessary for accurate work. The vertical adjustment of the slide permits the grinding of flat, broad surfaces greater than the diameter of the wheel. The work is ordinarily traversed by means of a rack and pinion operated by a hand wheel.

* * *

Where any apparatus, such, for example, as a small jib crane, has to be operated by hand power and which requires a considerable exertion of a man or a number of men, the location and throw of the crank become important. Apparently, experience has shown that a height of 32 inches above the ground or platform for the crankshaft and a crank length of about 16 inches (32 inches throw) suits the average laborer best. For light exertion the crank length should be made only about one-half this diameter, or, say, 8 inches, and should be elevated so that the crankshaft is, say, about 40 inches above the floor level.

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RAILWAY MACHINERY

A SPECIAL EDITION OF MACHINERY FOR THE RAILWAY SHOP, DEVOTED TO LOCOMOTIVE AND CAR EQUIPMENT AND MECHANICS.

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We solicit communications from practical men on subjects pertaining to railway machine shop practice, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

FEBRUARY, 1907.

THE PERILS OF RAILWAY TRAVEL.

Going around as fast as the printing presses of the country can spread it is this statement credited to James J. Hill, the railroad man. It concerns us all: "Every time I undertake a railroad journey nowadays I wonder whether it is to be my last. The thing has grown to be uncertain. It is a fact, of knowledge to every railroad man, that in this day from two to three trains enter at times into every block of every system in the country. There is danger in it." We are not in a position to know whether this has actually been said by Mr. Hill or not but the newspaper that gave out the original statement, claimed to have it on good authority. In all events, such an opinion seems to be fully justified at the present time, and warranted by the three fearful accidents which were reported during the last few days of the past year. The situation is of supreme importance, and there can hardly be too much said upon the subject, nor can too strong words be used. We all have to make use of the railroads, and it is rather unpleasant to realize each time we enter a railroad car that we practically take our lives in our hands. The perils of sea were once referred to as the most dangerous of all, but to-day we cannot for a moment hesitate to say that one is far safer on an ocean liner than on an American express train.

* * *

RAILWAY IMPROVEMENTS OBSOLETE BEFORE COMPLETION.

An illustration of the rapidity with which some great engineering structures become obsolete is the magnificent Hoboken terminal of the Lackawanna Railway now nearing completion. This terminal is situated on the western water's edge of the Hudson, being a ferry and railway terminal. When completed it will have six ferry slips, a unique train shed of large area and a station building, the like of which does not exist in this country, so far as strength, solidity and durability are concerned. It is a steel frame building of very heavy design protected in every part with concrete and exteriorly with copper sheeting. The whole terminal structure will probably cost considerably over $1,000,000, but the development of the tunnel systems under the Hudson River, of which the Pennsylvania and McAdoo tunnels are examples, promises very shortly to make railway terminals on the western side of the Hudson unnecessary, especially for the commuter traffic. The ultimate development of suburban passenger traffic promises to be such that passengers will be deposited on Manhattan Island from the west without change of cars, going under the river to either downtown or uptown terminals. The difficulties of the ordinary railway terminal which requires extensive storage space for cars is entirely overcome by the loop system. The cars discharge the passengers and proceed on the return trip with only a very short stop, therefore when the major part of the traffic entering New York City makes the passage without change of cars, the present elaborate housing facilities referred to must of necessity be among the examples of largely useless engineering structures.

* * *

THE BOOTLICKS OF THE PRESS.

It is a painful and somewhat nauseating spectacle to note the frantic truckling of some of our railway contemporaries to the corrupt commercial interests that dominate or seek to dominate our railway systems. Anything that these pirates propose or put into effect is all right or is smoothed over in words calculated to palliate their commercial crimes or make them out as only venial sins at most. On the other hand, let any one raise his voice in protest at some of the many railway abuses that have grown up in the past few years and it is drowned in a chorus of noisy yapping no matter how exalted his position or how disinterested his efforts may be.

Our readers should not lose sight of the fact that there are two distinct classes in railway circles; those who have come in from the commercial side and those who have worked up from the bottom and are truly railway men. We believe that this latter class is composed, in general, of honest men who earn their living in a more or less thankless service, but who love it above all others. To such the truckling of the press referred to has no attraction. They resent the crimes and mismanagement of their superiors as much as any one else, and any publication which seeks favor by such a policy is making a bad mistake.

Our American railways are magnificent properties which are sharing in the enormous increment of wealth that has come with the present era of prosperity, but the men who move the freight, who make up trains, and risk their lives, health and reputation every day have shared very meagerly in this prosperity—unless we accept that the working of 16 to 18 or even 24 hours at a stretch without sleep, for a trifling overtime pay is such a sharing. When the practical railroader comes to his own the financial cormorants of Wall Street will no longer dominate the policies of our railways, and the yappers of the press will need to print something of practical value if they would have many readers.

* * *

RECIPROCAL DEMURRAGE.

On the principle that "what is sauce for the goose is sauce for the gander" a bill has been introduced in Congress by Congressman Martin B. Madden of Illinois which provides that demurrage charges may be preferred by shippers if the railways do not provide suitable facilities for handling shipments within reasonable time. If a shipper has asked for a less number than twenty-five cars it shall be the railway's duty to provide them within three days, and if for more than twenty-five cars are requested the time allowment is ten days. If the carrier fails to provide the cars within the time limit it shall forfeit to the shipper $1.00 for each day's delay and shall also be liable for all damages suffered by the shipper. The bill gives shippers forty-eight hours in which to load cars after delivery. If held longer than this period demurrage at the rates of $1.00 per day for the car is given the carrier.

Like almost all proposed railway laws this one may be unfavorably criticised but it has elements of justice. Many shippers have felt keenly the favoritism accorded to some shippers who are supplied cars in plenty, while other shippers must wait long periods for cars, oftentimes on a falling market. In the case of perishable goods it is of the utmost importance to all concerned that cars be provided at almost instant notice. Whether this is a physical possibility depends upon the number of cars a railway has at its disposal and the judgment with which they are distributed at the beginning of the shipping seasons. The present era of prosperity due to enormous crops all over the country has demonstrated very clearly that our railway facilities are inadequate, especially in the point of having cars sufficient to handle the crops. Acceleration of freight movement would greatly relieve the condition. It has been shown that the average freight movement is only about 61.6 miles per day, a most absurdly low rate of movement, due almost entirely to lack of terminal facilities and the policy of loading locomotives to the utmost limit of their capacity.

THE PRINCIPLES OF RATIONAL DESIGN.

When writing the comment in the January issue, on the difference in design in three bevel gear generating machines made by three different firms, each of whom had the same object in view, we were reminded of a conversation held some time ago with a machine tool designer whose name is familiar to the readers of MACHINERY. This designer made the assertion that there is but one design possible to suit a given set of requirements. Curiously enough he took this very case of the generation of the bevel gear as an example and explained with some detail the mental processes which had evolved a machine of this type he had recently developed. In the first place, range and capacity must be determined as the prime limiting requirements. Then the other considerations which enter into the design—the theoretical, constructional and commercial factors which make or mar the success of the machine, must be carefully considered. It was his belief that, with these requirements carefully listed, analyzed and followed, there must in any given case result a definite design—definite, that is, in everything except the most unimportant details. He was, indeed, quite confident that if the memory of this machine were blotted from his mind, upon undertaking the task again, the new lay-out would be practically identical with the first.

When one comes to think about it, is it not true that this procedure represents an ideal to which the designer will more closely approximate as he becomes more skillful? Its antithesis is surely all too common in shops which have not yet emerged from the Egyptian darkness of the days of "cut and try." Under these latter conditions, when a new device is to be worked out, a roughly constructed trial machine is built and set to work. The feed is too slow—it is speeded up; the machine has not enough belt power—the 5-step cone is removed and a 3-step cone substituted; these two handles interfere in certain positions—the controlling mechanism is rearranged to correspond; and so on, the resulting machine giving in its final and "perfected" form plain evidences of the haphazard way in which it was developed. Of course there must always be some factors in the design of a machine which are experimental, especially those which have to do with the commercial success of the device. But the successful designer is he who, from his own experience and from his ability to use the experience of others, can reduce to a minimum the indeterminate factors of the problem. With all these indeterminate factors finally determined in accordance with the state of the art at a given time, the ideal designer would perhaps pursue a train of thought resulting in a machine whose every detail of construction was pre-determined from the moment when he first put pencil to paper.

* * *

CONSIDERATIONS ON THE PERMANENCE OF CONCRETE STRUCTURES.

Those of our readers who are familiar with Boston will remember the Emancipation Statue in Park Square, where the Old Colony depot used to be. A concrete-steel garage, which is being erected here, seems to have aroused considerable interest among the inhabitants of that learned town. There is certainly something which appeals to the imagination in the idea of a monolithic structure, made without joint or seam. A light-hearted *Herald* reporter, referring to the above-mentioned building, has thus relieved his mind, paraphrasing the words of Napoleon's famous speech before the Pyramids of Ghizeh: "Fire cannot touch it, it can never wear out, all the king's horses and all the king's men could not budge it. Some day Mr. Lincoln will say to the bronze darkey: 'Rastus, from yon reinforced-portland-cement-concrete-steel automobile-garage forty centuries look down upon you.'"

There is, however, a serious side to this concrete-steel question, if the new material is anywhere nearly as permanent as we are led to believe. Europeans have long scoffed at the ephemeral character of our structures and the condition of perpetual change which is characteristic of our great cities. This condition, which now bids fair to be modified at least, has nevertheless been our salvation so far as the architectural beauty of our buildings and their fitness for their purpose is concerned; there is scarcely a building over twenty years old devoted to business in New York City, whose destruction would draw a tear from any eye for other than financial reasons. But now that we are beginning to build in this new material for future generations, it becomes the solemn duty of the designers and owners of each new structure of any importance to question themselves earnestly as to whether the design possesses enough grace of form and fitness for its purpose, to make it acceptable to our great-grandchildren's children. In structures designed for purely mechanical uses, with dimensions mathematically determined, there usually exists a simplicity and appropriateness which is in itself a near approach to beauty. In the case of other structures, however, it would seem as if the interests of the public were almost of sufficient importance to require the approval of the plans by a building commission, not only from the standpoint of safety, as is now done, but from artistic considerations as well.

* * *

KNOWING THE REASON "WHY."

When Charles B. Dudley said that the technical graduate who knows the reason "Why" will in a short time in practical life distance his fellow student who simply had covered a certain amount of ground and stored up a large array of facts, he struck the true keynote of success in the field of engineering. And this is true not only of technical graduates. It is equally true of any man in any station in life. The man who simply knows that certain things are so, without knowing the reason "Why," without having grasped the underlying principles, will find little use for his knowledge. The ability of application of principles is the secret of the success of most designers of machinery, and far more of men engaged in structural or civil engineering. It is very seldom that identically the same conditions reappear in the problems to be solved in either case. The machine designer, for instance, except in the case of machines which have nearly become standardized, meets with new conditions in every new machine he plans. The mere knowledge, however, complete and intimate as it may be, of the construction of another machine helps him but little. But the principles applied are nearly always the same. If he knows why certain transmissions of motion work better in one case, and others in another, if he knows why the heaviest strain on the parts necessarily must come in this direction and not in that, why the method of oiling which was very superior in one case would be a failure if applied to the conditions in hand, and so forth, if he knows why all these things are as stated, then he is far better equipped for the design of an efficient machine than if he had studied machine design for years as a matter of memory as is often done in technical schools.

This is the reason why so often men who have had no particular technical training but long practical experience are so often promoted to positions where the design of machines is either directly or indirectly their duty. It is not their practical training itself which fits them for these places. There are plenty of cases where men of little or no actual shop training have reached the highest efficiency in machine designing. It is because practical shop work usually teaches a man the reason "Why." The man who has no desire to learn the reason why, may work like an automaton at his machine in the shop for a dozen years and know less of the principles governing his work than does the apprentice with a mechanical and inquisitive mind after six months.

The technical school which teaches its students the reason "Why" rather than a great mass of facts, is the school that will in the end gain the best reputation. The principles of engineering can be taught, but their application is easier learned by actually doing, performing, than from text-books. The technical graduate who is equipped with a thorough understanding of the reason "Why" is the one possessed of the greatest asset for life, no matter what be the actual amount of formulas and rules crammed into his head. And the young man, whether he be a technical graduate or not, who is desirous of fully understanding what little he knows, rather than to know a great deal which he does not understand, he is the one who, other things being equal, will succeed.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

A new method of producing stronger iron castings, known as the Doherty process, injects a small quantity of dry steam into the cupola with the air blast. It is claimed that the resulting castings are 25 per cent stronger, and that they are cleaner and easier to machine than when produced without the steam blast.

A 3⅛-inch rock drill, at full work, has been found to require 28 to 32 indicated horsepower at the compressor, but the actual power used against the rock was determined in a certain case to be only 1.7 horsepower. On the basis of 28 horsepower at the compressor, consequently, the efficiency of power at the drill bit was only 6 per cent.—*Scientific American.*

Experiments made in Germany by Messrs. Erdmann and Köthner of Charlottenburg indicate that a substance having the characteristics of cork may be made by the action of acetylene on copper in the presence of heat. As yet, however, the product lacks the strength necessary for it to be a complete substitute for cork, and the probabilities are that it can never be made so.

The Societé Alsacienne d'Electricité, of Strasburg, Germany, has constructed an indicator for extremely high speeds, according to designs prepared by the inventors, Messrs. Hospitalier and Charpertier. The usual apparatus is replaced by a photographic arrangement by means of which a negative is produced instead of the usual pencil card. The instrument has been successfully used at speeds of 2,000 revolutions per minute.—*Railway Review.*

As a result of the practical tests which have been in operation in Sweden, with a view to electrifying the whole of the railway system of the country, the government is building at the Falls of Gullspang a large electricity station capable of producing not less than 150,000 H.P. According to the calculation of experts, it is expected to result in reducing by $400,000 annually the consumption of British coal.—*The Mechanical World.*

The statistics of cars and locomotives ordered in 1906, as compiled by the *Railway Age* (December 28, 1906), show that in 1906 5,642 locomotives, 3,402 passenger cars and 310,805 freight cars were ordered by the various railway companies. The number of locomotives and freight cars ordered show a falling off from the number ordered in 1905, being respectively 6,265 and 341,315. The number of passenger cars ordered in 1905 was 3,289.

The earliest search for iron on the Vermillion Range and in Minnesota was in the vicinity of Tower and Soudan in 1861, but, because of the lack of transportation facilities, no development was possible until the present Duluth and Iron Range Railway, chartered in 1874, was completed in 1888 and the actual opening up of the district was accomplished. At the present time ore is being taken from a single shaft on which 300 men are employed, where formerly there were thirteen shafts operated and 1,800 men were employed at one time. The season's shipment for the Soudan mine is stated to be approximately 225,000 tons of ore.

Tin-foil, which is extensively used for wrapping tobacco, certain food products, and other articles of commerce, is a combination of lead with a thin coating of tin on each side. According to the *Valve World* it is made in the following manner: First, a tin pipe is made of a thickness proportionate to its diameter; proportion not given. This pipe is then filled with molten lead and rolled or beaten to the extreme thinness required. In this process the tin coating spreads simultaneously with the spreading of the lead core and continuously maintains a thin, even coating of tin on each side of the center sheet of lead, even though it may be reduced to a thickness of 0.001 inch or less.

It is reported that Dunwoodie & Jackson, Glasgow, Scotland, have introduced producer gas plant as a substitute for gasoline engines, which, it is claimed, secures a considerable saving. The apparatus has been used on a 3½-H.P. Star automobile and a 30-H.P. industrial vehicle with satisfactory results. Either coke or charcoal may be employed, and it is stated that a 30-H.P. vehicle can be run for one hour on 19½ pounds of coke and 2 gallons of water. This represents an outlay for fuel of 6 cents per hour. The engine to which the apparatus is attached can be started from the cold in five minutes. The plant consists of a producer, fuel hopper, blower to supply air, small pump for feed water, gas cooler and air mixing valves and water tanks. The weight of a plant for a 40-H.P. car is stated to be less than 250 pounds.—*Horseless Age.*

A chimney 506 feet high will be built at the Boston & Montana smelter, Great Falls, Mont., to carry off the gases from the smelting furnaces; it will be the highest chimney in the world, as the highest at the present time is 460 feet, a chimney at Freiburg, Germany. The stack is designed to have an inside diameter at top of 50 feet, and an outside diameter at bottom of 75 feet. The location of the structure is 3,535 feet above sea level. The chimney top will be 742 feet above the charging floor of the furnaces. The Alphons Custodis Chimney Construction Co., of New York, N. Y., which has the contract for building the chimney, is putting up a brickyard near the site, for making the perforated radial brick of which the main shell will consist. The construction of the chimney is estimated to take a year's time, and will cost about $200,000, exclusive of the foundation. The total weight of the structure approximates 16,600 tons.—*Engineering News.*

A simplified method for transforming readings of the Fahrenheit thermometer into Centigrade values and *vice versa* is given in the *Naturwissenschaftliche Rundschau.* The ordinary formula:

$$C = \frac{5}{9}(F - 32),$$

where C is the number of degrees in Celsius or the Centigrade system and F in Fahrenheit's, is not adapted for very rapid calculation. This formula, however, may be written:

$$C = \left(\frac{1}{2} + \left\{\frac{1}{2} \times \frac{1}{10}\right\} \times \left\{\frac{1}{2} \times \frac{1}{100}\right\} + \ldots\right)(F - 32)$$

The three first terms in the series in the first parenthesis are usually near enough for any ordinary conversion. To transform, for example, 88 degrees F. we have $88 - 32 = 56$, and

$$28 + 2.8 + 0.3 = 31.1,$$

which calculation can easily be performed.

Shipments of iron ore from the important deposits in the north of Sweden to foreign countries are restricted by government regulation. In view of the favorable condition of the iron market the mining company had secured leave to ship 400,000 tons additional in 1906 and 600,000 tons additional this year. The stipulated quantity is 1,200,000 tons a year and an increase of 300,000 tons for this year had already been granted. In view of the fact that these natural deposits are in no way indebted for their existence to the present individual exploiters, but may be regarded as a gift of nature to the whole nation, and to coming generations as well as to the present, such government restriction is in no way out of place. In other respects than this the Swedish people have taken care of the interest of the future generation. Being one of the greatest lumber-producing countries in Europe the supply of lumber would gradually diminish if provisions were not made for the annual replanting of the forests. For this reason the laws of the country provide that a certain per cent of the area covered with forests shall be replanted yearly.

The Seamless Tube Company of America, which is affiliated with the Pittsburg Steel Company and whose works are situated at Monessen, Pa., has recently purchased four 300-horsepower Allis-Chalmers compound wound, non-reversible direct-current motors. Speed variation will be obtained by means of shunt field regulation and each motor will be furnished with a starting panel, including an automatic circuit breaker and switch. One motor will be connected by gears to a 20-inch two-high mill for rolling tubes. One will be direct-connected to a mill for piercing steel billets, and two will be connected by gearing to cold drawbenches for cold drawing tubes. The invasion of steel works and rolling mills by electric power has been revolutionary. It is doubtful if ten years ago the most sanguine friends of this means of power transmission would have predicted the common adoption in so short a space of time of electric power for driving heavy rolling mills. The line of improvement in this class of machinery which has done more than any other to encourage its adoption in mill operation has been that of developing a high torque at starting. Thus far the use of electricity has reached no limit in iron and steel works operation, and its more recent success, in driving the heaviest rolling mill, leaves apparently little that cannot be conquered.

We have received a little booklet from the Decimal Association, 605 Salisbury House, London, England, giving Lord Kelvin's views on the advantages of the metric system and the opinions of several other eminent Englishmen, etc. The arguments are pro-metric and about what might be expected from scientists not intimately acquainted with the practical difficulties of introducing the metric system into manufacturing plants where the English system is established. A suggestion for the convenience of translation of metric and English units is worthy of notice, although it only applies where no great accuracy is required. It would apply to the rougher measurements, such as are required for railway rails, structural steel girders and other material of construction. These may be translated from the English measurements of inches, quarters, eighths, sixteenths, etc., to millimeters with a discrepancy amounting to 1-128 in one inch, as follows:

By taking 1 inch = 25.6 millimeters in place of 25.4 millimeters,

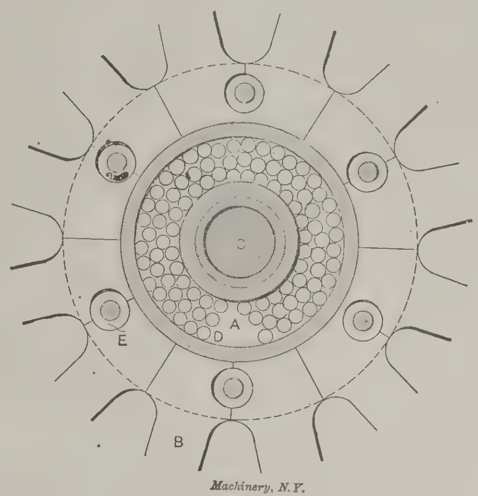
then 1-2 inch = 12.8 millimeters.
1-4 inch = 6.4 millimeters.
1-8 inch = 3.2 millimeters.
1-16 inch = 1.6 millimeters.
1-32 inch = 0.8 millimeter.
1-64 inch = 0.4 millimeter.
1-128 inch = 0.2 millimeter.

Two great engineering schemes are at present under consideration in England. The first one is the revived proposition of connecting England and France by a tunnel under the English Channel. Although a bill has been deposited in Parliament for the incorporation of the Channel Tunnel Company there is room for doubt whether the scheme will ever be carried out. Admitted that it is feasible from an engineering point of view, would the tunnel be able, for instance, to successfully compete with large railway ferries, if such were installed to ply between Dover and Calais? However, we congratulate those in authority for having finally decided that there are no military objections to the tunnel, as it has been always claimed that the tunnel would offer a great opportunity for an invading army. How that can be, we on this side find hard to understand. The most desirable position in which we, for instance, could place an invading army seems to be in one of the tubes under the Hudson river. But then, we are only laymen in military matters.

The other great engineering undertaking to be financed in England but to be carried out in South Africa is the transmission of power by means of electricity from the Victoria Falls to Rand, a distance of about 700 miles. The original proposition provides for a transmission of 50,000 H. P., but it is intended to increase this to 150,000 H. P. While this seems an enormous undertaking, there seems to be greater feasibility as well as usefulness in this latter proposition than in the tunnel scheme.

SHOCK-ABSORBING HUB FOR MOTOR CARS.

The Practical Engineer shows a new type of wheel hub devised to prevent destructive vibrations from being transmitted to the body of the vehicle from the axle. The hub, called the shock-shifting hub, is filled with steel balls loosely packed, which support the axle. The weight of the axle, carrying the vehicle, automatically forms the vacant space *A* as shown in the cut, and this space is constantly maintained when the wheel is in motion. Any shock to the wheel from the road may be considered as traveling up a spoke situated



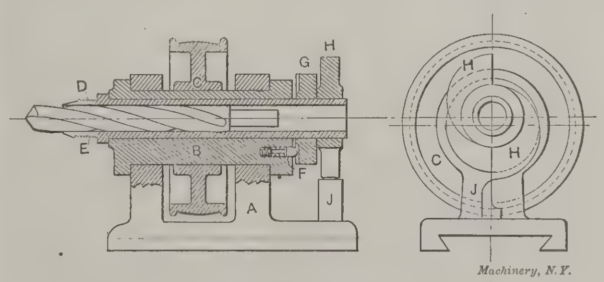
Shock-absorbing Hub.

as *B* and the ordinary course of such a shock is direct to the center of the axle *C*. Owing, however, to the mobile condition of the balls resting on one another and always ready to slip over each other, revolving on their own axes, a row of balls beneath the axle (marked *D* in the diagram) is immediately displaced. These balls are forced across the vacant space *A* and, followed by other balls, cause the shock to pass into the ball chamber in the backward moving half of the wheel. The road shock is thus broken up in its transmission, almost absorbed, and prevented from ever reaching the axle. It is claimed that the movement of the car is extremely steady, because there is no reactionary shock on the wheel such as invariably must result where springs are utilized or even where rubber alone in any form is applied to lessen the vibration.

AUTOMATIC DRILL GRINDER.

Zeitschrift für Werkzeugmaschinen und Werkzeuge, Nov. 15, 1906.

The cut illustrates a device which is the subject of a recent German pattern for grinding twist drills. Only the headstock of the machine is here shown. To the headstock frame *A*, which is slowly fed along the bed of the machine toward a grinding wheel placed at a suitable angle to it, is journaled the revolving bushing *B* driven by a continuously rotating



Automatic Drill Grinder.

pulley *C*. The bushing *B* is bored eccentrically to carry drill holding bushing *D*, which may be changed to suit the diameter of the drill being ground. A threaded cap acting on the tapered and split end of this sleeve serves to hold the drill firmly. *D* is free to revolve in *B* except for the restraining action of spring plunger *F*, which seats in either of the two shallow grooves milled opposite each other on the inner face of collar *G* as shown. Collar *G* is fast to sleeve *D* and revolves with it. Attached also to *D* is the double-winged stop

cam H whose radial faces are adapted to engage with the fixed stop J on to the headstock casting.

The operation of the mechanism as just described is as follows: With the parts in the position shown and pulley C rotating in the right-hand direction, stop cam H is in position to be free from stop J, so that C, B, and sleeve D, with the contained drill, revolve as one piece under the influence of plunger F seated in the groove in the face of collar G. This revolution of the drill about an eccentric axis past the angular face of the wheel grinds the end of it in a form to give suitable clearance to the cutting edge. At the end of half a revolution from the position shown, the upper leaf of stop cam H has been brought around in contact with stop J which arrests the motion of G, D, and the work. Continued movement on pulley C and sleeve B raises the drill, carrying its axis in a semi-circular path without, however, rotating it. This path carries the cutting edge treated away from the face of the grinding wheel. Plunger F was of course unseated from the groove in collar F as soon as stop cam H came in contact with J. At the completion of the second half revolution, however, the parts are again in the position shown in the cut, except that the plunger F has dropped into the other groove in its opposing collar and the other lip of the drill is ready to be sharpened. The process is thus a continuous one and only the gradual feeding forward of headstock A toward the wheel is needed to give a suitable form to the cutting edges of the drill.

[This device is very interesting as an example of the ingenious accomplishment of a somewhat complicated operation with very simple means, but in the matter of building a practical machine upon the principle here illustrated, we are in some doubt. The adjustments that would be required to fit the device to drills of different sizes would be so cumbersome as to apparently limit the usefulness of the scheme.—Editor.]

HARDENING STEEL BY ELECTRICITY.

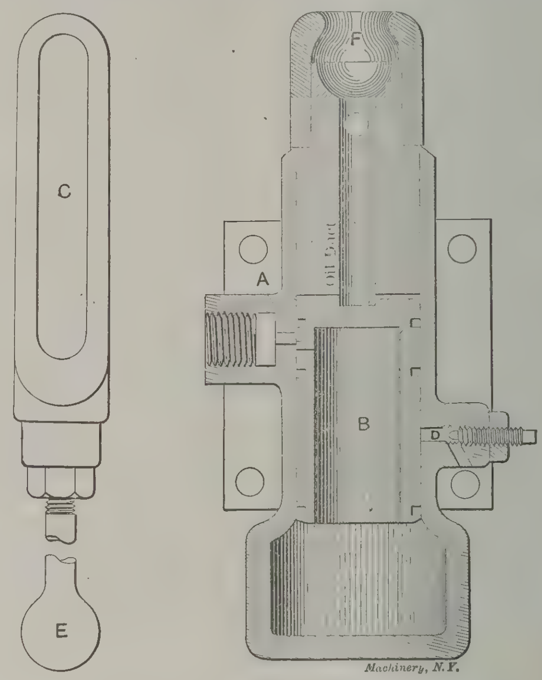
There are about sixty different methods of hardening steel, each of which has its advocates, and no one of which is suited for all sizes and shapes of articles, or for all kinds of steel. One way which has not yet come into general use is hardening by electricity, and is described by Garnier in the *Genie Civil.* The process is simple and the appliances necessary neither complicated nor costly; neither is any great amount of previous experience in this particular manner of hardening required. The tool to be hardened is put in electric connection with the positive pole of the battery or other source of current; in similar connection with the negative pole there is a cast-iron tank full of carbonate of potash dissolved in water. The current is regulated by a rheostat. The tool is plunged to the desired depth in the solution, just as for hardening in the usual maner; the current is then switched on and the tool heated to the same degree as would be required in ordinary hardening. When the proper temperature has been reached and held for the desired time, the current is switched off and the tool left in the bath, which latter, by the simple act of switching off the current, is at once converted into a hardening bath.

Another method, which permits of hardening places on the surface of pieces, where the dipping process would not accomplish the desired object, is local heating with the electric arc. Here the tool or other article is laid on a copper block, and an ordinary arc carbon held in a safety holder; the electric connections with holder and block being made, the carbon pole is touched to the piece to be locally hardened. Of course the heating is both intense and local; the work-piece is at once plunged in the ordinary hardening bath, and when one place is hardened the next may be heated, and so on. The electric current may also be used to draw the temper of a hollow object. Instead of using a red-hot iron rod to plunge in the bore, a cold rod is employed, which is used as a resistance in the circuit of a secondary current of about two volts tension. The temperature of the iron rod gradually rises, and when the work-piece has reached the desired color, the current is shut off. This method is said to produce less liability to cracking than the old-fashioned way of drawing the temper with a hot rod. It is particularly recommended for large hollow mills. The great advantage consists in the perfect regulation possible by means of a rheostat, and in the possibility of getting exactly the same temperature every time for similar objects, once the right heat and color are attained.

R. G.

SIMPLE LOCOMOTIVE BELL RINGER.

The *Railway Master Mechanic* illustrates and describes a simple locomotive bell ringer, which is operated by compressed air. The special features of advantage of the device are its durability, simplicity of construction, and minimum air consumption. The mode of operation is as follows: Air entering at port A starts the piston B upward, which movement promptly closes the inlet port, the expansion of the air completing the stroke of the piston. When the bottom of the piston reaches port D, enough air exhausts to allow the weight of the bell to force the piston down, closing the exhaust and compressing the air in the chamber, which compression, with a slight addition of air at intake keeps the bell in motion



Simplified Locomotive Bell Ringer.

with the least consumption of air. It will be noted that there are no valves, packing rings or oil cups required, as oiling the ball bearing lubricates the piston through a small oil hole shown in the cut. At C the bell crank yoke is shown with its adjustable connecting rod and ball, the latter fitting in the socket F.

THE POULSEN SELECTIVE SYSTEM OF WIRELESS TELEGRAPHY.

A new system of wireless telegraphy that gives considerable promise of solving the extremely difficult problem of selectivity, i.e., the transmission and reception of a number of messages in the same field of force simultaneously and without interference, has been devised and tried out by Valdemar Poulsen, the well-known inventor of the telegraphone. Ever since 1897, when Sir Oliver Lodge applied to wireless telegraph transmitters and receptors the combination of open and closed circuits, and introduced the methods of tuning the circuits at either station individually and syntonizing them collectively, have persistent efforts been made by physicists and others to secure a suitable degree of resonance by providing the proper values of inductance, capacity, and resistance, and when these conditions prevailed, it was concluded the receiving resonator system would respond to a specific radiating oscillator system and to this one only.

These efforts seem to have met with a measurable degree of success in the case of Poulsen's system, which differs greatly in principle from that of Marconi, the former making use of what is termed undamped electric waves. The difference between these waves and those employed in Marconi's system is not easy to explain to one who is not an electrical expert; but using sound waves as an analogy the difference

may be roughly illustrated by comparing the electric waves used in Marconi and similar system to the violent agitation caused by a pistol shot, and Poulsen's undamped electric waves to the continuous vibration of a tuning fork, and just as a pistol shot will cause all the strings in a piano to vibrate and a tuning fork only the particular string giving the same note, so undamped electric waves exercise a selective influence of much greater delicacy than the violent discharge used in the present systems. One great advantage promised for the new waves is the possibility of tuning them and varying their length and amplitude so greatly that multiplex telegraphy may be carried on without the risks of interference to which present systems are so liable. Many attempts have been made to solve the problem of producing undamped electric waves of a sufficient high frequency and energy for practical purposes, and Poulsen's success is attributed to his having ascertained the peculiar properties manifested by an electric arc when immersed in an atmosphere composed of or containing hydrogen, whereby he has been able to obtain a million or more vibrations per second.

It is stated that a dozen messages have been transmitted and received between as many experimental sets by means of this new selective system without interference; and if this extraordinary result can be duplicated over distances of 50 or 100 miles, as the experiments thus far made between the inventor's two Danish stations indicate, an advance will have been made that, in its importance, will be second only to the introduction of wireless telegraphy itself.

THE INFLUENCE OF TEMPERATURE ON THE FRAGILITY OF METALS.

M. G. Charpy, in Memoirs de la Societe des Ingeniurs Civils, Paris, October, 1906.

This paper deals with the determination of the liability of steel to break from shock, as affected by the temperature. The results obtained show such a marked change in the rigidity of the specimens at different temperatures as to indicate that the question is one of greater importance than generally considered. After reviewing briefly the work done by other experimenters, the author describes the preparation of the test pieces employed in his investigation. Five large ingots were

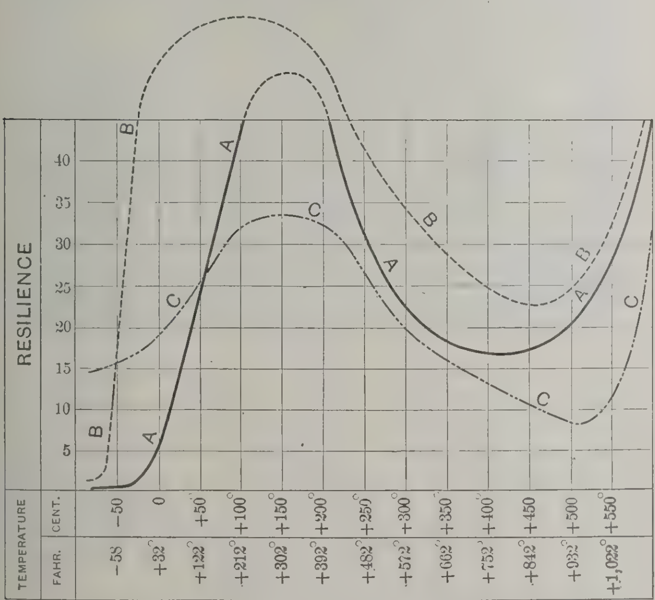


Fig. 1. Variations of Fragility with Temperature in Mild Steel.

prepared having the following characteristics: Ingot A, an extra mild steel of the quality generally obtained by the Thomas process; *B* a very pure mild steel made in the Martin furnace; *C* a semi-mild steel made in the Martin furnace and submitted during the solidification of the metal to compression by wire drawing in accordance with the Harmet process; *D* a semi-hard steel containing a little nickel, made in the Martin furnace; *E*, a Chrome-nickel steel made in the Martin furnace. The following table gives the composition of these different steels.

COMPOSITION OF STEELS USED IN TESTS.

	C	*Mn*	*Cr*	*Ni*	*S*	*P*
A	0.04	0.33	....	....	0.02	0.05
B	0.14	0.28	....	....	0.006	0.005
C	0.21	0.60	...	...	0.03	0.03
D	0.36	0.34	....	1.10	0.01	0.01
E	0.36	0.37	1.60	3.50	0.005	0.02

From each of the large ingots (which were carefully worked) smaller test pieces were cut about 30 millimeters square and 160 millimeters long. Both by microscopic examination and by testing of specimens taken from widely separated portions of the ingot, care was taken to insure that the quality of metal should be practically the same throughout. The tests made to determine this showed that the end had been practically accomplished. The test pieces were all submitted to a prolonged temperature of about 900 degrees Centigrade to remove internal strains so far as possible, and all

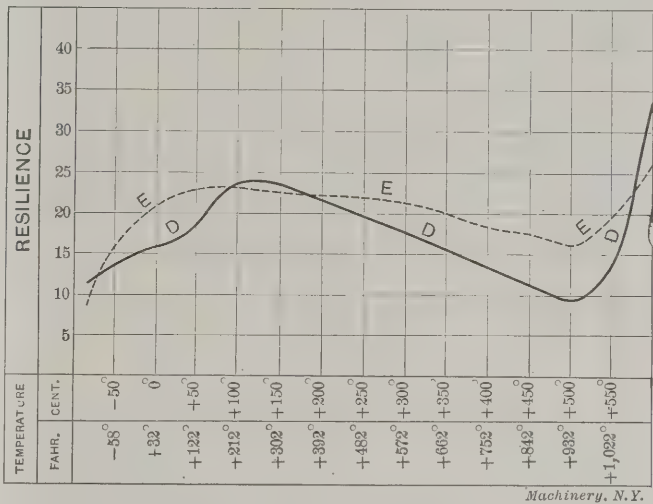


Fig. 2. Variations of Fragility with Temperature in Chrome and Nickel Steels.

the bars of each metal were given an individual tempering treatment to give to each the minimum amount of fragility possible.

In testing these specimens the bars were notched to a depth of 15 millimeters, the bottom of the notch having a radius of 4 millimeters. They were then tested in a pendulum hammer machine, of usual type. Here they were subjected to a series of rapid blows, each of which had a definite intensity in foot pounds or kilogrammeters. The number of blows received by the specimens before fracture is thus a measure of the resilience of that small section of the material exposed in cross section at the notched portion.

The bars were placed in a bath maintained at the temperature desired for the experiments in hand, this bath being of ether or of acetone for low temperatures, of water or oil for medium temperatures, and of chlorides or melted alkaline azotates for high temperatures. Each specimen was seized with the tongs and placed on the supports of the testing machine, where it was submitted to the shock. The time that elapsed between the taking of it from the bath and the breaking was always well within ten seconds, so one can be sure that the variation of temperature was negligible. The following temperatures were experimented with: —80 degrees, —18 degrees, +6 degrees, +30 degrees, +97 degrees, +200 degrees, +290 degrees, +350 degrees, +425 degrees, +500 degrees, +600 degrees. Two specimens of each metal were tested at each temperature.

The results are graphically represented in the curves of Figs. 1 and 2. It will be seen that for all the steels tried, the resilience (which varies inversely with the fragility) increases as the temperature is raised until the maximum of between 100 and 200 degrees is obtained, then it diminishes, attaining a minimum of between 400 and 500 degrees, representing the fragility at the blue color; then it is again raised as the temperature increases until the red heat is attained. The variations are, above all, important for the mild metals.

It is striking to note that for metal A the variation in passing from +20 degrees to —20 degrees lowers the resilience in the ratio of 6 to 1. Metal B'_1 which is of a similar kind but much more pure, likewise undergoes enormous variations, though they are less important from a practical standpoint. It is nevertheless remarkable that this metal which is able after suitable thermal treatment to bend back on itself in the notched section at the ordinary temperature, breaks like glass at a temperature of —80 degrees, absorbing an amount of work scarcely measurable, and becoming at that point much more fragile than the metals of Fig. 2.

The special semi-mild steels appear to present a great superiority from the point of view of the influence of temperature on fragility. Metal E of chrome and nickel steel, which offers a resistance to breakage by tension of about 80 kilograms, possesses at ordinary temperature a resilience of about 16 kilogrammeters, which descends to only about 14 kilogrammeters when cooled to a temperature of —80 degrees.

The practical conclusions which are to be drawn from this experiment are then: First, that by the employment of special steels (of the Chrome-nickel order) the dangers of the variation of the fragility by change of temperature can be almost entirely avoided, even those relating to the fragility at a blue heat. Second, that the increase of fragility at low temperatures should be taken into serious consideration in the case of mild steels, above all when these steels are mediocre as regards their purity, for under such circumstances their increase of fragility is sufficiently rapid and of sufficient intensity to give rise to severe accidents.

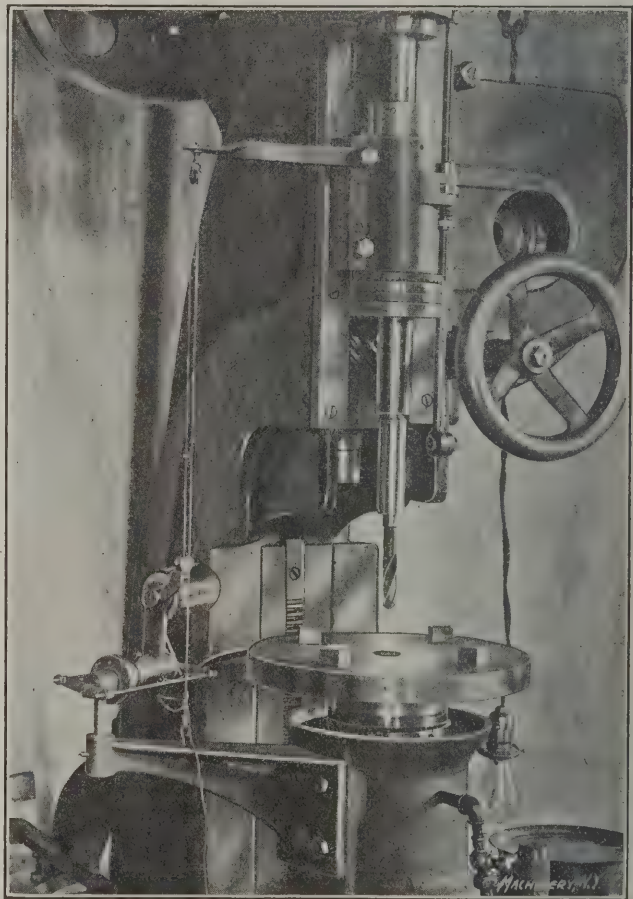
TEST OF TWIST DRILLS AT WORCESTER POLYTECHNIC INSTITUTE.

Journal Worcester Polytechnic Institute.

Some recent experiments of great interest to toolmakers and machine builders have been made with high-speed drills at the Worcester Polytechnic Institute. To carry out these tests a special machine was designed and built, being exceptionally strong and heavy, it having been found that the thrust necessary to push a drill through a piece of metal was very much greater than is generally supposed. An ordinary drill press did not permit the drills to be used up to their full capacity. The most important parts of the machine built are shown in the cut below. The range of feeds obtainable vary from 0.0045 to 0.0225 per revolution of the spindle. The dynamometer for registering the thrust and twisting moment of the twist drill when tested was very simple and efficient. A hollow piston with a round top to form a table was scraped to fit a cast-iron cylinder. The cylinder was filled with heavy cylinder oil and had an ordinary pressure gage tapped into the lower end. The gage gave the reading in pounds per square inch and in order to get the thrust of the drill it was necessary to multiply by the area of the piston which was about 20 square inches. To measure the twisting moment a steel band fastened to the enlarged top of the piston was connected to an indicator spring by means of a steel rod screwed into the bottom of the indicator piston. Since the area of the indicator piston was only ½ square inch, and the force was applied direct, the indicator spring had to be rated at ½ of the value it would have when used in a steam indicator. The movement of the drum of the indicator was obtained by passing a cord over a pulley which was attached to the carriage of the spindle and then fastening the end to a projecting arm of the dynamometer. Taking the average force as registered by the indicator diagram and multiplying by the radius of the round table gave the twisting moment. In none of the tests did the moment exceed 350 inch pounds which was obtained with a ⅞-inch drill running at a speed of 328 revolutions per minute, and a feed of 0.0225 inch per revolution. This was the largest size drill with which tests were undertaken.

It had, previous to these tests, been found that there was a great variation of the thrusts obtained from drills of the same diameter working under the same conditions. This depends upon the fact that the thickness of the web of the drill varies quite widely for the same diameter of the drill even on tools manufactured by the same maker. Mr. Fairfield of the Worcester Polytechnic Institute has deduced from common practice the law that beginning with a drill of 0 diameter and estimating a thickness of web equal to 1/64th inch the thickness of the web should increase 1/64th for every increase of ⅛ inch in diameter of the drill. Expressing this in a formula: If D be the diameter of the drill, and W the thickness of the web, we would have $W = \frac{D}{8} + \frac{1}{64}$. All the drills used in the test had as far as possible a thickness of web corresponding to this formula. The drills were made of Novo steel and the test pieces were of cast iron of as uniform composition as possible.

Of the results of the tests, those which will mostly interest toolmakers are those referring to the angle of the lip of the drill. As is well-known manufactured drills have a constant angle of the lip of 59 degrees. Several tests made with a ⅝-inch drill, varying the angle of the lip from 37½ degrees to 70 degrees, show that the 59-degree angle is not the most desirable one. In fact, the tests show that with different angles



Machine Arranged for Twist Drill Tests.

of lip the thrust decreases from 70 degrees down to 45 degrees and then increases for any further decrease in angle. The twisting moment, however, does not seem to stand in any relation whatever to the angle of the lip but is very nearly proportional to the feed of the drill. From this it would appear that a 45-degree angle ought to give the best results in practical machine shop work. According to the *Journal Worcester Polytechnic Institute* there is only one instance in which the 45-degree angle is given the preference over the common angle of 59 degrees, and that is the case of the Wm. Sellers Co., Philadelphia, Pa.

RAILWAY MOTOR CARS.

There has of late been a great increase in the use of self contained motor cars for passenger service on European railroads, and there has been a marked advance in the same direction in this country in cases where the railroads have found themselves called upon to handle a large suburban traffic. It is therefore of interest to note a review of the best use of such cars presented to the (British) Institution of Mechanical Engineers as reported in *The Engineering Magazine.*

The best method of conveying passengers, clearly, is that one which yields the best results in the balance sheet, and at the same time gives satisfaction in other ways. The opinion held by most locomotive engineers, and by a large number of electrical engineers, on the broad and general question of railway electrification, is that for close suburban traffic only is it justifiable. It is suggested and maintained that the electrification of branch and main line traffic will, as a general rule, result in a loss to the railway company, as the load-factor at the power-station will be a very poor one, owing to the intermittent traffic. On the other hand, suburban traffic, especially if in thickly populated areas, calls for a more frequent service and a greater acceleration of speed than is attainable with ordinary passenger trains. It is obviously impracticable to use ordinary trains to meet the demands of a frequent service, on account of the cost, the running expenses and the capital outlay being too great in proportion to the number of passengers. Turning then to the question of self-contained cars, comes the necessity for deciding the type of motive power. For such a service electricity is naturally considered, and in some cases the conditions are such that electric traction is manifestly superior. The railroad man, however, must look to the commercial side of the question, and a close examination of the subject shows that lines where the service is necessarily light and intermittent, and where the distances to be run are several miles, the power house would need to be large in proportion to the average work done; and where heavy gradients have to be worked, the peak load would be large in proportion to the average and minimum, and rapidly fluctuating therefrom. The necessarily large units which would have to be provided in the generating station to meet this maximum motor power and high peak load, would be costly, and consequently the capital outlay would be out of proportion to the work done.

For these reasons English railroads have found, after careful investigations and calculations, that the electrification of steam railroads for suburban service is not the most economical or preferable course, but that the introduction of self-contained steam cars is by far superior from the financial point of view. In regard to the comfort of the passengers, however, one would be inclined to look more favorably upon the electric cars.

Disregarding the motive power the advantages of self-contained cars are plainly in evidence, and these are put forth as follows: Owing to the small unit, a much more frequent service is given with a better percentage of load to dead weight hauled, while the mileage cost of working is only about one-third the cost of an ordinary passenger train-mile. The facility of picking up and setting down passengers at line crossings, small villages, etc., makes the service more popular, and enables many passengers to travel who would not otherwise be able to. The rapid rate of acceleration makes the through speed higher. The experience of those railways who have given both an extensive trial is that the system is equally advantageous for heavy and sparse traffic. In the first case the motors sandwiched in between the regular trains find a traffic without taking it away from the trains, while in the second the traffic has been developed by the more frequent service. The number of steam-cars at present running proves their utility, and it seems certain that in them railways have the best, and in fact the only, effective answer to street-car competition.

THE FIRST MACHINE FOR THE COMMERCIAL PRODUCTION OF WINDOW GLASS BY THE SHEET PROCESS.

Scientific American, December 1, 1906.

The manufacture of window glass is one of the few arts which seem to have resisted all the efforts of the keenest mechanical intellects to raise it from the station of a handicraft which involves much costly and cumbersome human labor, to the dignity of an automatic process. The hand-blown cylinder method by which the bulk of window glass is made at the present time is not merely very simple, but almost primitive even in its crudeness. The process, which is almost too well known to require description, consists briefly in blowing a large mass of plastic material to the shape of a cylinder of uniform diameter and thickness, open at each end. It is then cut open, rolled out flat, heated and annealed. The only successful method which has been made to improve on this process was the introduction of machinery for drawing and blowing cylinders, and window glass to-day is made largely by this means, although it is not considered an important advance in the art.

By far the most systematic and painstaking study which has been made of the whole problem we owe to Mr. Irving W. Colburn of Franklin, Pa. He has attacked it on every conceivable side, expended large sums in experimenting, built and destroyed machine after machine, and, after eight years, has produced the first commercially successful apparatus for drawing sheet glass of any reasonable width, thickness, surface and polish, desired. After a long series of failures along the more obvious lines of passing plastic glass through heated rollers (a process impracticable on account of the marking of the surface produced) and after a long series of failures in other directions, he gave up the direct solution of the problem for a time and devoted his energies to the manufacture of window glass by the cylinder process, which he succeeded in improving to a marked degree. Efficient as his improvements were, however, they fell far short of what would be expected of a machine which would be able to draw glass from the furnace in continuous sheets. Aside from the fact that the slightest touch of a roller on the surface of the sheet marked it to a degree that rendered it useless for window purposes, the greatest difficulty in this was that, like all plastic substances, the glass as it is drawn from the reservoir of molten material, tends to contract more and more as the tractive pressure is maintained.

To prevent this Mr. Colburn hit upon the method illustrated in Fig. 1. In this plan spheres of fireclay are employed, carried on the ends of long arms which are immersed in the glass and which are made to revolve upwardly and outwardly, and away from the two edges of the sheet. These spheres impart an outward motion to that portion of the surface of the molten mass lying adjacent to the edges of the sheet, thereby counteracting that tendency to shrink and draw to a thread which is the property of all such materials. By this means he was enabled to draw continuously sheet glass of any desired width and of a thickness varying at the will of the operator from 1-16 to 1-4 of an inch.

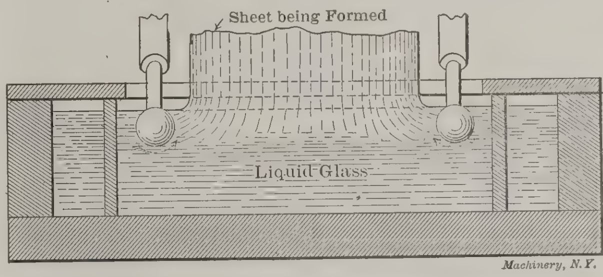


Fig. 1. Method for Preserving Width of Sheet in First Machine.

Complete success was not, however, immediate. Ribs or wave-like lines or striæ were formed upon the surface of the finished product in some unaccountable way. An elaborate study of the conditions which caused these formations was now undertaken. After observations and experiments extending over a year, it was discovered that the defect was due to several causes, among which was the tendency of the glass to receive on its surface impressions from the rough side walls of the pot, particularly if the point at which the glass left the walls was only a few inches from the point at which the glass entered the sheet. Moreover, the chilling influence of the atmosphere on the surface of the glass, while molten in the working chamber, caused it to lie dormant in spots and also to wrinkle slightly. These defects were hardly perceptible to the eye, but existed nevertheless, and were bound to cause the disastrous wave lines when the glass entered the sheet form.

Mr. Colburn found that by placing near and on each side of the sheet a rotating fireclay cylinder D, slightly immersed in the molten mass (Fig. 2), and at the same time superheating remote portions of the glass, the difficulties were overcome. These rollers are rotated in opposite directions during the operation of drawing the sheet of glass, and serve not only

to impart movement to a portion of the surface of the molten mass away from the edges of the sheet during the drawing operation, but also to determine the area of the surface in the working chamber or pot, which is more or less exposed to the cooling influences of the atmosphere, the superheating occurring on that portion of the surface of the molten mass to the rear of the rollers. These rollers make but one revolution in from ten to thirty minutes, depending upon existing conditions, and serve also as a most perfect equalizer of temperature of the molten glass in the working chamber, which is an absolutely necessary factor in drawing an even thickness of sheet glass. A film of plastic glass adheres to these rollers and is carried upward and over the rollers, chilling slightly in the chamber *A*, because of the presence of the water jackets *C C*, which are inserted, one on each side of the emerging sheet of glass. These jackets are not designed to chill or thicken the sheet, but merely to screen off the heat radiating from the revolving white-hot clay rolls. The plastic film of glass on the rollers melts off entirely in the superheating chambers *B B*.

As the sheet of glass is drawn from the mass of glass lying between the rollers, and as the spheres impart an outward movement to that portion of the surface of the mass lying immediately adjacent to the edges of the sheet, the following effects are observed: The molten glass at and just beneath the surface adjacent to the edges of the sheet moves outwardly and away from the central line of the sheet, thus serving to hold the sheet to its full width. As the sheet moves upward

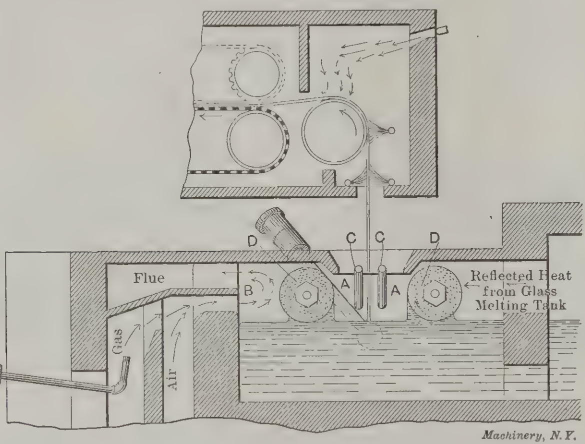


Fig. 2. Cross-section of Perfected Continuous Sheet Machine.

there is drawn into it some of the surface portion of the molten mass immediately adjacent to its two faces, and also some of the molten glass beneath the surface. The skin or surface portion of the glass in the working chamber adjacent to the sides of the sheet being drawn, becomes the skin or surface of the finished drawn sheet. Simultaneously the two rollers on opposite sides of the sheet of glass skim some of the surface portion of the molten glass lying between the rollers and the sheet of glass away from the sheet. The result of the combined action of the drawing of the sheet and the movement of the rollers is a constant skimming of the molten glass lying between the two rollers, so that a fresh portion or a new surface is constantly being exposed to the cooling effect of the atmosphere, which has not time to form wave lines on its surface before it has passed into the drawn sheet or over the revolving rollers. Furthermore, the rollers serve to bring a supply of fresh and uniformly heated molten glass into the area lying between the rollers and the sheet. The glass which is skimmed from the surface by the rollers and carried over them is subjected to the superheating action in the chambers *B B*, as already explained, and is melted down so as to free the rollers from the adhering film, and restore the film itself to a proper working condition. Simple as the expedient of the rollers may seem, it meant months of painstaking observation and experimenting before they were conceived.

Operated by three shifts of men, of eight hours each, three men to a shift (one man filling in the batch to the continuous glass-melting tank furnace, one man watching the operation of the sheet-drawing apparatus, and one man cutting off the glass into sheets and removing them as the sheet emerges from the end of the annealing leer) this machine will produce sheet glass continuously, month in and month out, twenty-four hours a day, stopping only for repairs. The glass leaves the machine at an approximate rate of from fourteen to twenty-eight inches a minute (depending upon whether thick or thin glass is being drawn), and uniform quality of glass is maintained regardless of the speed at which the glass is drawn. Glass much thicker than the heaviest double-strength window glass, as well as the single-strength, can be produced with perfect ease, the quality being midway between the best hand-blown and plate glass. The surface presents a most beautiful fire polish.

After the sheet has been formed it passes from a vertical to a horizontal travel over an idler or bending roller into an annealing leer, which bending roller receives the power necessary to start and keep it in motion from frictional power mechanism acting in conjunction with the frictional contact of the traveling sheet of glass. This combined application of power to the bending roller prevents it from marking or scratching the finished sheet. The glass is rendered sufficiently flexible at the bending point by a series of gas flames, as illustrated in Fig. 2.

* * *

ON THE ART OF CUTTING METALS.—2.*

FRED. W. TAYLOR

ACTION OF TOOL AND ITS WEAR IN CUTTING METALS.†

The Action of the Nose of the Tool.

In Figs. 1, 2 and 3 is illustrated in enlarged views the action of a tool in cutting a chip or shaving from a forging at its proper normal cutting speed. It may be said in the case of all "roughing cuts" that the chip is torn away from the forging rather than removed by the action which we term cutting. The familiar action of cutting, as exemplified by an axe or knife removing a chip from a piece of wood, for instance, consists in forcing a sharp wedge (*i. e.*, one whose flanks form an acute angle) into the substance to be cut. Both flanks of the wedge press constantly upon the wood, one flank bearing against the main body of the piece, while the other forces or wedges the chip or shaving away.

While a metal cutting tool looks like a wedge, its cutting edge being formed by the intersection of the "lip surface" and "clearance surface" or flank of the tool, its action is far different from that of the wedge. Only one surface of a metal cutting tool, the lip surface, ever presses against the metal. The clearance surface, as its name implies, is never allowed to touch the forging. Thus "cutting" with a metal cutting tool consists in pressing, tearing or shearing the metal away with the lip surface of the "wedge" only under pressure, while in the case of the axe and other kinds of cutting, both wedge surfaces are constantly under pressure.

After the cut has once been started, and the full thickness of the shaving is being removed, the action of the tool may be described as that of tearing the chip away from the body of the forging and then shearing it up into separate sections; the portion of the chip which has just been torn away, and which is still pressing upon the lip surface of the tool, acting as a lever by which the following portion of the chip is torn away from the main body of the metal.

It may be of interest to analyze to a certain extent the nature of the forces to which a chip and the forging from which it is being removed are subjected through the tearing action of the tool. The enlarged view of the chip, tool and forging, shown in Fig. 1, represents with fair accuracy the relative proportions which the shaving cut from a forging of mild steel (say, 60,000 pounds tensile strength and 33 per cent stretch) finally assumes with relation to the original thickness of the layer of metal which the tool is about to remove.

* Abstract of paper presented before the American Society of Mechanical Engineers, December, 1906.

† As the purpose of these abstracts is to give the results of experiments that will be of direct value in the shop rather than to give a complete record of the experiments themselves—interesting though they are—we have of necessity left out much interesting and valuable matter. The limits of space do not permit the alternative of giving the paper complete. Copies of the complete paper can be obtained from the secretary of the American Society of Mechanical Engineers, 29 West 39th Street, New York. Price, $1.00.—EDITOR.

It is, of course, impossible to accurately determine the extent to which various parts of the chip and forging close to the tool are under compression and tension, but in general the theory advanced is believed to be correct.

Referring to Fig. 1, the forging being cut and the nose of the tool which is removing the chip are shown on an enlarged scale. The thickness of the layer of metal about to be removed is indicated by L between the dotted line and the full line which represents the outside of the forging. It will be observed that the chip is in process of being torn apart and broken up into three sections: Section 1, which is adjoining the forging; section 2, which comes next to it, and in which rupture or cleavage has started and proceeded a little way up from the bottom of the chip and on the left hand side, the shearing action having progressed as far as T_2; section 3, in which shearing has progressed about two-thirds of the way to the top of the chip and is taking place at T_3. Section 4 has been entirely sheared from its adjoining section, and has already left the lip surface of the tool.

On examination of the proportions of the chip it will be noticed that the width of the sections into which the chip breaks up is at their base about double the thickness of the original layer of metal which is to be removed, and that their upper portions are not enlarged to the same extent. These

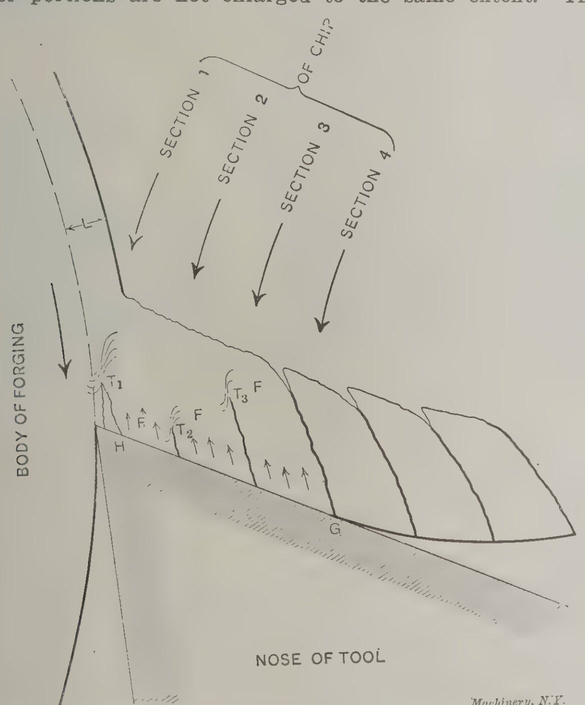


Fig. 1. Showing how Chip is Partly Torn and Partly Sheared from Body of Forging.

sections are about three times as high as the original thickness of the layer of the metal to be removed. It should be clearly understood that the dimensions of the section of the chip will vary with each hardness of metal which is being cut, and also to a certain extent with the sides and back slopes of the lip surface of the tool. The harder the metal of the forging, the less will each section into which the chip has been broken up be found to be enlarged. In other words, if the same shaped tool be used in each case the chip from soft metal enlarges or distorts very much more than the corresponding chip from hard steel. This will be referred to later, in explaining the reason why the total pressure on the tool has but little relation on the one hand to the cutting speed, and on the other hand to the hardness of the metal which is being cut.

The chip bears on the surface of the forging, say, from point H to point G, and throughout this distance is under constant compression from the lip surface of the tool. This compression is transmitted through each of the sections 1 and 2 of the chip, in the direction indicated by the small arrows, to the upper portions of these sections, which are still unbroken and act like a lever attached to the upper part of section 1 to to tear section 1 away from the body of the forging, as indicated at point T_1. The tearing away of section 1 is also assisted by the pressure of the tool upon its lower surface.

After this tearing action has started, the further breaking of the chip into independent sections would seem to be that of simple shearing. It should be borne in mind that in shearing a thick piece of steel the whole piece is not shorn or cut apart at the same instant, but the line at which rupture or cleavage takes place progresses from one surface of the piece down through the metal until within a short distance from the other surface, when the whole remaining section rather suddenly gives way.

In shearing steel, the metal at the point of rupture is pulled apart under a tensile strain, although on each side of the shearing line the metal is under heavy compression.

As each of the sections of the chip successively comes in contact with the lip of the tool, its lower surface is crushed, and the metal flows and spreads out laterally until it becomes about twice its original thickness. As in all shearing, when the full capacity for flowing of the metal has been reached, it tears apart under tensile strain from the body of the adjoining metal of the forging. The compression on the chip from the tool still continues, however, and the chips continue to flow and spread out sideways at a part higher up; *i. e.*, farther away from the surface of the tool, at the portions marked F. In the same way shearing continually takes place at the left side of the portion of the chip which is flowing or spreading out sideways.

There is no question that shearing takes place constantly along the left-hand edges of two of the sections of the chip at the same time, and it is probable that this action occurs most of the time along three lines of cleavage.

Dr. Nicolson's dynamometer experiments show that the pressure of the chip on the tool in cutting a chip of uniform section varies with wavelike regularity, and that the smallest pressure of the chip is not less than two-thirds of the greatest pressure. From this it is evident that shearing must be taking place along at least two lines of cleavage at the same time; since if each of the sections into which the chip is divided were completely broken off before the tool began to break off the following section, it is evident that there would be times when there was almost no pressure from the chip on the tool.

It is at first difficult to see how it is possible for the chip to be shearing at two or three places at the same time. It should be noted, however, that above the points T_1 T_2 T_3 the metal of the chip is still a solid part of the forging, and moves down at the same speed as the forging in a single mass, or body, toward the lip surface of the tool; and with sufficient force to cause each of the three sections of the chip to flow or spread out at the parts indicated by the three letters F. According to the laws which govern shearing, rupture or cleavage in each case must take place as soon as the maximum possibility for flowing has been reached, and in each case shearing must occur at the left of the zone where the metal is flowing.

It is probable that after the shearing action has progressed in section 3 to about the point indicated by T_3, the whole of this section gives way or shears with a rather sudden yielding of the metal from T_3, to the upper surface of the chip. It is this rather sudden shearing point which undoubtedly causes the wavelike diminution in the pressure of the chip indicated in Dr. Nicolson's experiments.*

Action of Cutting Edge of Tool is that of Scraping. Cutting Edge not under Heavy Pressure.

It would appear that the chip is torn off from the forging at a point appreciably above the cutting edge of the tool and this tearing action leaves the forging in all cases more or less jagged or irregular at the exact spot where the chip is pulled away from the forging, as shown to the left of T_1. An instant later the line of the cutting edge, or more correctly speaking, the portion of the lip surface immediately adjoining the cutting edge, comes in contact with these slight irregularities left on the forging owing to the tearing action, and shears these lumps off, so as to leave the receding flank of the forging comparatively smooth.

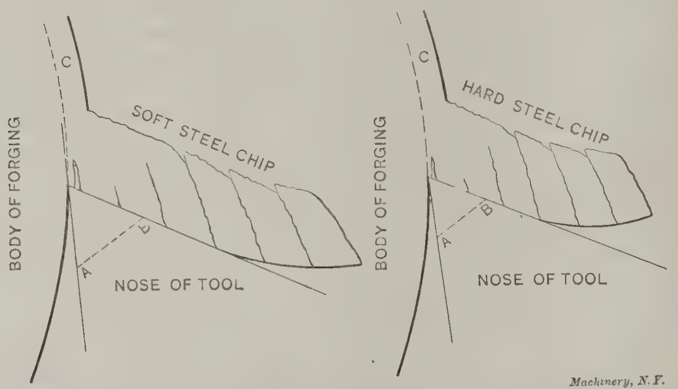
Thus in this tearing action, particularly in the case of cutting a thick shaving, while the cutting edge of the tool is

* Manchester Municipal School of Technology, 1902 and 1903.

continually in action, scraping or shearing off or rubbing away these small irregularities left on the forging, yet that portion of the lip surface close to the cutting edge constantly receives much less pressure from the chip than the same surface receives at a slight distance away from the cutting edge. This allows the tool to run at higher cutting speeds than would be possible if the cutting edge received the same pressure as does the lip surface close to it.

There are many phenomena which indicate this tearing action of the tool. For example, it is an everyday occurrence to see cutting tools which have been running close to their maximum speeds and which have been under cut for a considerable length of time, guttered out at a little distance back of the cutting edge, as shown in Fig. 8. The wear in this spot indicates that the pressure of the chip has been most severe at a little distance back from the edge.

Still another manner in which in many cases the tearing action of the tool is indicated is illustrated in Fig. 4, in which a small mass of metal is shown to be stuck fast to the lip surface of the tool after it has completed its work and been removed from the lathe. When broken off, however, and carefully examined, this mass will be found to consist of a great number of small particles which have been cut or scraped off of the forging, as above described, by the cutting edge of the tool. They are then pressed down into a dense little pile of compacted particles of steel or dust stuck together and to the lip surface of the tool almost as if they had been welded. In the case of the modern high speed tools, when this little mass of dust or particles is removed from



Figs. 2 and 3. How Hard and Soft Chips Bear upon the Lip Surface of Tool. The Soft Chip covers a Much Larger Area of the Lip Surface.

the upper surface of the tool, the cutting edge will in most cases be found to be about as sharp as ever, and the lip surface adjacent to it when closely examined will show in many cases the scratches left by the emery wheel from the original grinding of the tool.

With roughing tools made from old-fashioned tempered steel, however, and which have been speeded close to their "standard speeds," in most cases after removing this "dust pile" from the lip surface, the cutting edge of the tool will be found to be distinctly rounded over. And in cases where the tool has been cutting a very thick shaving, the edge will be very greatly rounded over, as shown in the enlarged view of the nose of a tool in Fig. 9.

Nature of Wear on Tools Depends upon whether it has been Chiefly Caused by Heat.

The appearance of tools which are worn down so as to require regrinding differs widely according to whether or not the heat produced by the pressure of the chip has been the chief cause of wear; and according to the part which heat has played in producing the wear, worn out tools may properly be divided into three classes.

The First Class.—Tools in which the heat, produced by the pressure of the chip, has been so slight as to have had no softening effect upon the surface of the tool.

The Second Class.—Tools in which the heat only slightly softens the surface of the tool during the greater part of the time that it is cutting, while during the latter part of the time heat is the chief cause of wear because, as described in the third class, it greatly softens the lip surface under pressure of the chip.

The Third Class.—Tools in which the heat has been so great as to soften the lip surface of the tool beneath the chip almost at once after starting the cut, and in which, therefore, heat has played the principal part in the wear of the tool.

In the first class, in which heat plays no part in the wear of tools, all tools (whether made from carbon tempered steel, or from the old style self-hardening steel, or from the modern treated tools) wear in about the same manner. Namely, the lip surface just back of the cutting edge is slowly rubbed or worn or ground down through the friction of the chip, as shown in Fig. 7.

As the surface of the tool through the long rubbing of the chip becomes slightly roughened, the tool wears away somewhat more rapidly, but the increase in the rapidity of wear is in this case by no means marked.

On the other hand, tools which wear according to the third class begin to distinctly deteriorate within from one to three minutes after the chip has started to cut, depending upon the length of time required for the friction of the chip to raise the tool from its normal cold state to the high temperature which corresponds to the combination of pressure and speed which produces the heat. And the moment the nose of the tool has reached a degree of heat at which the metal under the chip becomes distinctly soft, the wear then proceeds with great rapidity. Sometimes after arriving at a certain degree of softness, the heat remains approximately constant, and the wear upon the tool continues at a uniformly rapid rate until a comparatively deep groove or gutter has been worn into the lip surface. At other times after the lip surface of the tool begins to soften, it appears to become rougher and cause a still greater amount of friction and heat, in which case the wear of the tool proceeds at an increasingly rapid rate, and the tool is soon destroyed. There are rare instances in which after the rapid wear has started, the friction between the chip and the tool, for some unaccountable reason, appears to become less and the tool slightly cools down. Cases have come under the observation of the writer in which tools which had been running with their noses at a visible dark red heat, cooled off to such an extent that the chip which had been very dark blue in color changed to a color but slightly darker than a brown. This indicated a very marked diminution in friction, although the cutting speed was maintained at a uniform rate throughout. This case, however, is of rare occurrence.

While a deep groove worn by the chip is a characteristic of wear of the third class, by no means all of the tools in this class wear into a deep groove. Most of them give out before the groove has had time to wear deep. After wear of the third class has started, tools will generally be completely ruined in a time varying from 20 seconds to 15 minutes, and the time which elapses between the softening of the lip surface and the final ruining of the tool is exceedingly irregular. One of two tools—which have been proved through standardization to be uniform within, say, 1 to 2 per cent, may give out within one minute after this action starts, while the other may last 15 minutes. On the other hand, occasional lots of tools are found which, after having been proved uniform through standardization, will last under this softening speed for approximately the same length of time.

Reason for Adopting a Standard Test Period of Twenty Minutes.

It is this irregularity in the ruining time of tools belonging to the third class which has led us to adopt a trial period of 20 minutes as being the *shortest ruining time* from which it is safe to draw any correct scientific conclusions from tests in the art of cutting metals.

A cutting speed which causes the tool to be ruined in a shorter period than 20 minutes is accompanied by such a high degree of heat as to produce irregularity in the ruining time; on the other hand, a speed which ruins at the end of 20 minutes is accompanied by that degree of heat at which tools, generally speaking, can be depended upon to wear uniformly. In other words, it represents the degree of heat at which a lot of uniform tools will all give out at about the same time.

Economical Cutting Speeds.

Cutting speeds which are sufficiently slow to cause the tool to wear as described in the first class are entirely too slow

for economy. On the other hand, tools when run at the high cutting speeds which produce wear of the third class last so short a time that these high speeds are entirely out of the question for daily shop use.

It is then with cutting speeds causing wear of the second class that we are chiefly concerned; as it is within this range of cutting speeds that almost all roughing tools in every day use should be run for maximum all-round economy. Cutting speeds of this class are referred to as "economical speeds" or "most economical speeds." Our experiments, therefore, have been practically confined to a study of cutting speeds of the second class.

A cutting speed which will cause a given tool to be ruined at the end of 80 minutes is about 20 per cent slower than the

run at their "economical" or "standard" speeds, pass through the following characteristic phases as they progress toward the point at which they are finally ruined: "Rounding of the cutting edge," "mounting of the steel upon the lip," and the "rubbing away beneath the cutting edge"; but it will be understood of course that all progress simultaneously, although each of these phenomena may be separately considered.

Long before the tool is ruined the fine particles of steel or dust scraped off by the cutting edge begin to weld or stick to the lip of the tool and mount upon it sometimes from 1/16 inch to ¼ inch in height, as shown in Fig. 4.

As stated above, in the case of modern high-speed tools, the damage caused to the tool through the action of cutting is confined almost entirely to the lip surface of the tool. Doubt-

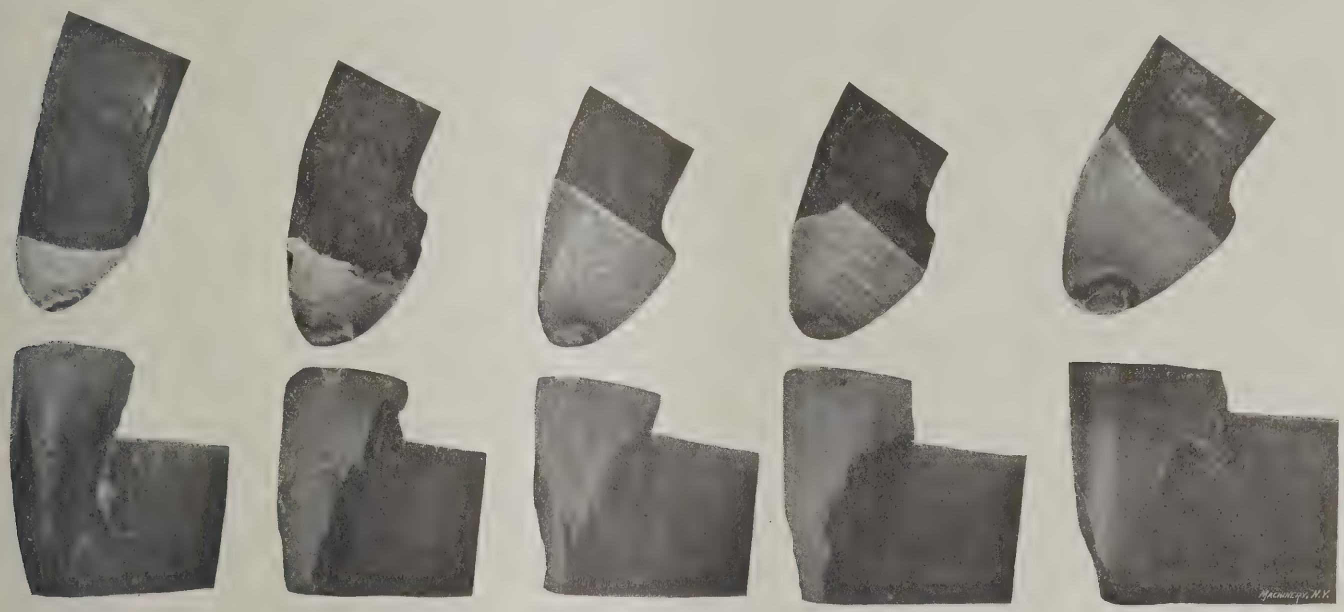


Fig 4. Fig. 5. Fig. 6. Fig. 7. Fig. 8.

cutting speed of the same tool if it were to last 20 minutes. On the whole, we have concluded it is *not* economical to run roughing tools at a cutting speed so slow as to cause them to *last for more than one and one-half hours* without being reground.

Some of the Characteristic Points of Difference in the Wear of Carbon Steel Tempered Tools and Tools Made from Old-fashioned Self-hardening Steel as Compared with High-speed Steel.

With carbon steel tempered tools at standard speeds the cutting edge begins to be injured almost as soon as the tool

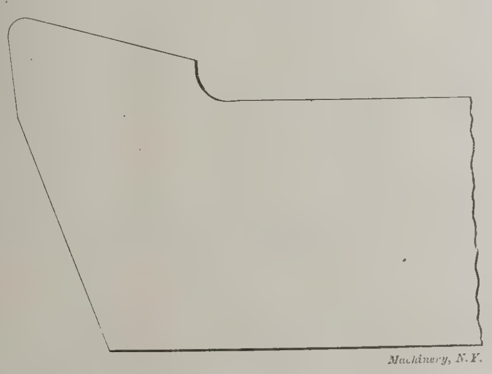


Fig. 9. Showing how the Cutting Edge of Carbon Steel Tools sometimes Rounds Over.

starts to work, and is entirely rounded over and worn away before the tool finally gives out, but the tool works well in spite of its cutting edge being damaged. While with high-speed tools at standard speeds, the cutting edge remains in almost perfect condition until just before the tool gives out, when even a very slight damage at one spot on the cutting edge will usually cause the tool to be ruined in a few revolutions.

Carbon tempered tools and also, to a considerable extent, the old-fashioned self-hardening tools (such as Mushet), when

less also the metal right at the cutting edge of the tool remains harder than it is directly under the center of pressure of the chip, because the cutting edge is next to and constantly rubs against the cold body of the forging, and is materially cooled by this contact.

Whether the lip surface be ground away at high speeds or at slower speeds, the nose of the tool is generally "ruined" in a very short time after the cutting edge has been so damaged that it fails to scrape off smoothly even at one small spot the rough projections which have been left on the body of the forging by tearing away the chip. The moment the body of the forging begins to rub against the clearance flank of one of these high-speed tools at or just below the cutting edge, even at one small place, the friction at this point generates so high a heat as to soften the tool very rapidly. After a comparatively few revolutions, the cutting edge and flank of the tool beneath it will be completely rubbed and melted away, as shown in Fig. 5. A tool which was still in "fair" condition when removed from the lathe although showing some slight signs of ruining is shown in Fig. 6.

The above characteristic of holding their cutting edges in practically perfect condition while running at economical speeds up to the ruining point is a valuable property of the high-speed tools, since it insures a good finish, and the maintenance throughout the cut of the proper size of the work, without the constant watchfulness required on the part of the operator in the case of old slow-speed tools with their rounded and otherwise injured cutting edges, which when run at economical speeds were likely at any minute to damage the finish of the work. But when one of these high-speed tools is nearing its ruining point, a very trifling nick or break in the line of the cutting edge will be at once noticed by its making a very small but continuous scratch, projecting ridge, or bright streak, on the flank of the forging, that is, upon that part of the forging from which the spiral line of the chip has just been removed, thus warning the operator of the impending breakdown of the tool.

STRENGTH OF BOILER JOINTS.

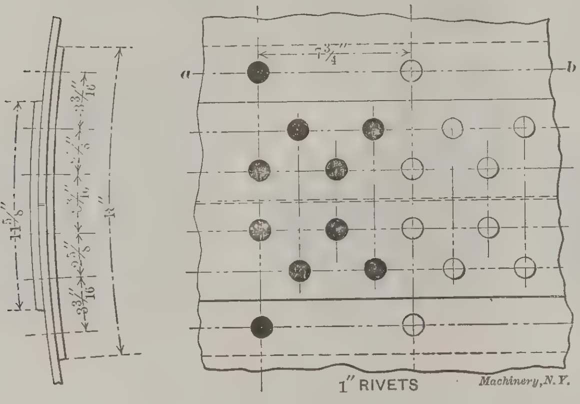
L. A. A.

The calculation of the strength of a boiler is not a difficult operation. The main question is that of the boiler seams. The maximum working pressure is generally the first thing known or given. The inner diameter of largest course is easily found, or is determined by the amount of steam needed. Now we will need to measure, or obtain, the thickness of boiler plate to be used. Let the pressure be given as 200 pounds per square inch, and the radius as 29 inches. The tensile strength of boiler plate varies considerably and can only be known accurately by trial of test pieces. In the case we are to work out let us assume 55,000 pounds per square inch for good steel plate. A suitable factor of safety to assume at the outset, is 6, when figuring on solid plate which has not been weakened by rivet holes. Using the well established formula,

$$\frac{\text{Tensile strength}}{\text{Factor}} \times \text{thickness} = \text{pressure} \times \text{radius}$$

or $\frac{f_t}{F} \times t = PR$, that is,

$$t = \frac{P \times R \times F}{f_t} = \frac{200 \times 29 \times 6}{55,000} = 0.632.$$



Triple-riveted Butt Joint.

With these values we will have a ⅝-inch plate. Let us take for example, a boiler having the seam shown in the cut, which is a triple riveted butt joint for ⅝-inch plate (a longitudinal joint recommended by the Hartford Steam Boiler Inspection and Insurance Co.).

Inside radius of largest course in shell $= R =$ 29 inches.

Maximum boiler pressure $= P =$ 200 pounds.

Thickness of boiler shell $= t =$ ⅝ inch.

Diameter of driven rivets—(same as rivet holes) $= d =$ 1 1/16 inch.

Area of rivet holes $= A$.

Pitch of outer row of rivets in seam $= p =$ 7¾ inches.

Number of rivet shears in length of seam "p" $= n =$ 9.

Tensile strength of plate $= f_t =$ 55,000 pounds per sq. in.

Shearing strength of rivets $= f_s =$ 38,000 pounds per sq. in.

First, we will find the *efficiency* of the seam for tearing, that is, the strength of plate left when rivet holes are taken out of distance "p," the pitch, compared to the solid plate which would be 1. This is found by using tables of efficiency of seam (see Supplement) directly:

$$E = \frac{p - d}{p} = 0.863.$$

Now we will proceed to find the two factors of safety; one for tearing the plate and the other for shearing the rivets.

Factor of safety (tearing) $= F_t$

$$\text{Using the formula, } F_t = \frac{E \times (f_t \times t)^*}{P \times R} = \frac{.863 \times 34,375}{200 \times 29} = 5.11$$

Factor of safety (shearing rivets) $= F_s$

$$\text{Using the formula, } F_s = \frac{n \times A \times f_s}{P \times R \times p} = \frac{303,231}{200 \times 29 \times 7\frac{3}{4}} = 6.74$$

From table showing shearing resistance of rivets (see Supplement), we get the total product, $n \times A \times F_s = 303,231$.

It will be seen from the above that the seam is strongest in the strength of rivets, as the factor is 6.74 compared to 5.11, which is the factor of safety on the tearing of the plate. Now as 5 is an ample factor of safety in ordinary boilers in new work, we can rest assured as to the safety of this boiler.

When the water to be used is liable to corrode the boiler it is customary to take off 1/16 inch from t and allow for this. Plotting from these tables will give curves which are very valuable on account of enabling the designer to obtain results intermediate between those on tables.

Referring to the table on rivets (see Supplement) it will be noted that 38,000 was used as shearing strength of rivets. This is a fair average for good wrought iron rivets. A thumb rule of making the rivets twice the size of plate, in our example would give us 1¼-inch rivets, but it will be seen that 1-inch rivets are ample, and are enough to give a large factor of safety. The rivet holes are generally made 1/16 inch larger than the rivet to be used, and as the rivet fills the hole after being driven, the size of the hole is used in the calculation table. An efficiency of seam of 0.85 or over is desirable if possible, but this alone does not determine the strength of a boiler, and this quantity is often allowed smaller, according to style of seam used.

[The procedure here outlined is a good one for determining the dimensions of a proposed joint, but the joint thus determined should still be tested for strength by other methods of failure than the two just given. Shearing at the outer row of rivets and tearing at the middle row may, for instance, give a lower factor of safety than tearing at the outer row.—Editor.]

* From table of Boiler Calculation (see supplement) we get $(f_t \times t) = 34,375$ using 55,000 for new steel plate and the given thickness of plate "t" $= \frac{5}{8}$.

* * *

A system of standards is the order of modern life, and in many directions standards are convenient if not, in some cases, indispensable. We have, for instance, standard gages for railways and tramways, standard threads for various screws, and so on. But there are still some directions in which the need of a standard is not only indicated but is urgent. The desirability, for example, of standardizing the steps of all staircases is seen in the fact that so often a fall on the staircase is due to the irregularity in the height of the steps. A common cause of accident on the staircase is the kicking of the edge of a stair when ascending. In descending also, an irregularity in one step may easily upset the equilibrium of a person. Yet how many staircases are constructed absolutely alike as regards the height of the steps? We should say very few; and not only is there little uniformity existing between different staircases but the steps themselves in the same staircase are often irregular. Staircases and the steps in them should be standardized; there should be uniformity of height and breadth, and in regard to the latter there should be room enough on the step to accommodate the whole foot from toe to heel, so that there is no undue call on the energies when ascending, as by going on tiptoe, so to speak, or any feeling of insecurity when descending by reason of there only being room for the heel. Even in dark places the staircase, if standardized, would be more safely negotiated than a well-illuminated but irregular stairway. The perils of an ordinary ladder would be enormously increased if the rungs were placed at irregular intervals.—*Lancet.*

* * *

A remarkable improvement in incandescent electric lamps is reported to have been made by Prof. H. C. Parker and Mr. Walter G. Clark of Columbia University, New York. The new lamp is claimed to have from three to four times the efficiency of the ordinary incandescent lamp using a simple carbon filament. The filament is a compound structure with a carbon filament as its base on which are deposited other materials including silicon; it is called "helion," because its spectrum is similar to that of the sun. It is also claimed that the new filament of the new lamp will last nearly twice as long as the carbon filament, giving as high as 1,270 hours service and an average of about 1,000 hours service before failure. An efficiency of 1 watt per candlepower hour has been reached with the helion filament lamp. The ordinary 16 candlepower incandescent lamp requires from 50 to 54 watts as against say 16 watts for the new lamp.

FINISHING CUTS WITH HIGH-SPEED STEEL.

ROBERT GRIMSHAW.

At a meeting of the Hanover section of the German Engineers' Society, I made the remark, in speaking upon a very interesting paper by Prof. Hermann Fischer, that my experience with the new high-speed steels went to show that, while they would rough out about three to five times as fast as the carbon steels, they were not to be recommended either for finishing cuts on the lathe, or for milling cutters; and that my own rather expensive experience was backed up by the results obtained by others in Germany. This remark was simply laughed at by the author of the paper in question; and the chief engineer of the Egestorff Works agreed with the learned professor that the new steels did first-class work in lathe finishing and in milling. In order to fortify myself in the premises I wrote to a number of leading German machine builders, noted for turning out good work and plenty of it, and asked for their experience in the matter. Their testimony coincides without exception with my own, and I take pleasure in giving abstracts therefrom as an interesting contribution to the literature of the subject.

It should hardly be necessary to say that the reason why we should not expect proportionately as good work in finishing as in roughing is that the new steels, almost without exception, require to be almost, if not quite, red hot, in order that their molecules may arrange themselves in mechanical grouping or in chemical combination so as to give the maximum hardness, and that in consequence of the high speed required to get this temperature, and their tearing rather than cutting action, the surfaces obtained are not so smooth as those got with the carbon steels.

The experiments of Prof. Haussner, of Brunn, go to show that a slight increase in specific power required to produce turnings accompanies an increase in the speed of cutting; and this is at once the cause of the new tools getting hot when roughing, and the reason why they cut so fast. But in finishing on the lathe or planer, there is less heat developed than in roughing. In milling, there is, in the first place, no machine that will give the speed required to make the tool red hot; and in the second place the weight and cross-section of the body of the mill, in proportion to the cutting portion proper, is so great that in any case only slight heat developed by the work is rapidly carried away from the point of application of the cutter. Further, the teeth are not constantly at work, as is the case with the point of a lathe tool; and each tooth has a chance to cool off "between bites." This being the case, we have not the combination of circumstances tending to produce that high temperature of the cutting point, or points, necessary in the case of the new steels to do fast work. In a paper before the American Society for Testing Materials, Mr. Metcalf said in effect (I quote from memory): "As far as we know, the users of high-speed steel have not been able to make tools that will finish satisfactorily; therefore, they use for this purpose carbon-steel tools, after they have done the heavier, rougher work with the high-speed steels."

But to get down to the promised testimony of German tool manufacturers and machine builders:

The Zahnräderfabrik, formerly Joh. Renk, Augsburg, writes: "We have had the best of results with the new steels in milling, planing, and turning; for finishing on the lathe high-speed steel is not at all necessary. These are our results:

CUTTING FEEDS AND SPEEDS FOR HIGH SPEED STEEL.

Material.	Cutting Speed per min.		Feed.		Depth of Cut.	
	Meters	Feet.*	Millimeters.	Inches.	Millimeters.	Inches.
Cast Iron (without skin).....	9	29.52	2	.079	6	.236
Cast Iron (with skin).........	8	26.24	2	.079	5	.197
S.M. Steel (without skin).....	11	36.08	1.5	.058	6	.236
Steel Casting (with skin)...	9	29.52	1 to 1.5	.0394 to .058	5	.197

* All equivalents in British units added by the author.

"The above cutting speeds are about twice as great as with the ordinary steel. Our machines do not permit of taking heavier cuts, and for the same reason we could not attain higher speeds."

De Fries & Co., Düsseldorf, say: "The rapid steels are used by us only for roughing, while fitted surfaces are ground." They also say, in reference to the speeds attained in roughing when the machine is suitable for the work, that these depend upon the hardness and toughness of the material being cut, upon the feed, etc., and vary from 6 to 30 meters (19.68 to 98.4 feet) per minute.

The Vereinigte Schmirgel- und Maschinen-Fabriken, Hainholz near Hanover, write in very great detail:

"We introduced the self-hardening steels in our works about a year and a half ago, for lathes and planers. In order to get the best results we tried eight different makes. The principal materials worked are cast iron and ingot iron. In the case of gray iron the crust made a great difference. The high-speed steel does not stand up to its work on the skin any better than the ordinary steel. In order to get good results, the skin must be taken off at the same time with the rest. As in a paying works it does not do to remove much material, say, for small pieces 2 to 3 millimeters (0.08 to 0.118 inch), for larger work 4 to 6 millimeters (0.16 to 0.236 inch) it must be understood that at times the tool must work on the crust, too. For average gray iron with a depth of cut of about 5 millimeters (0.197 inch) our maximum cutting speed is from 13 to 15 meters (42.6 feet to 49.2 feet); with harder cast iron, 10 to 12 meters (32.8 to 39.4 feet).

"The maximum work attainable can be got in one of two ways: either by low cutting speed and heavy feed, or by high cutting speed and less feed. The first seems the better way. As far as the working of Bessemer steel and castings is concerned, the limits lie higher. For us, the figures are as follows:

"Ingot iron, unforged, 20 to 24 meters (65.6 to 78.72 feet); ingot iron, forged, 18 to 20 meters (59 to 65.6 feet); ingot steel, 20 to 30 meters (65.6 to 98.4 feet); crucible steel, 5 to 7 meters (16.4 to 22.96 feet), according to depth of cut and feed.

"By reason of the heavy work that the high-speed steel has to do, the heat of friction comes unpleasantly into the foreground; this being manifested by heavy pressure on the lathe centers. There are also limits set to the cutting speed on long thin shafts, by reason of the bending of the work-piece. When remarkably high cutting speeds are given in circulars and examples of work done, it is to be understood that these refer to roughing cuts, such as are usual in steel works. In machine building, however, accuracy is demanded; that is, as exact a surface as possible. If we finish at high speeds, chattering occurs, despite all precautions. And in practice, that means a rough surface.

"Outside of this, however, the self-hardening steel is at a disadvantage in contrast with the ordinary. As has been shown often, as for instance in '*Stahl und Eisen*,' No. 10, of 1904, the chips or turnings are not removed by the cutting edge proper, but torn off under heavy pressure. This necessarily yields a rough surface. If, however, we finish at the ordinary speeds, such as are right for the ordinary steel, say 5 to 7 meters (16.4 to 22.96 feet), the surface will be smooth. The self-hardening steel can here hardly claim precedence over the ordinary. It is noteworthy that H. Wohlenberg of Hanover says in his circular of lathes with triple backgears: 'For roughing cuts at high speeds with fast-cutting steels and for finishing cuts with ordinary steel.' In our workshops the fast-cutting steels are used almost exclusively for roughing, and at the speeds suited to each material; above all for the skin of castings.

"For all that, the introduction of high-speed steel is of enormous importance. There are materials that cannot be worked at all with ordinary steel. Now we use these new steels at moderate speeds. This is true of boring and planing. A great evil is the high price, 5 to 7 marks per kilogram (55 to 77 cents per pound avoirdupois). But this can be partly eliminated by the use of toolholders, much to the displeasure of the steel dealers. With us, the welded tools are much liked, especially by the planer hands.

"As regards the grinding of the high-speed steel, the circu-

lars always say 'grind only wet.' That is not right. As you know, in grinding, hair-cracks easily occur, which under certain circumstances can lead to trouble. We grind only on emery wheels. If in wet grinding the tool is pressed a little too hard against the disk, the cooling-water does not reach the place of contact, but flows over the edge of the tool, so that the latter is cooled in front and heated strongly on the back, which gives rise to hair-cracks. If, however, the grinding is done on a dry wheel, the steel will be heated uniformly; this will not injure it, provided the temperature does not get too high. It is therefore better to grind these tools carefully on a dry wheel. In general, we can say that the self-hardening steels have made themselves much liked by the workmen, although at first they fought against them tooth and nail."

Körting Bros. of Körtingsdorf near Hanover, a firm of world-wide reputation, say: "We have gone back from a formerly quite liberal purchase of high-speed steel, because we found that most of our lathes were too weak for them. For our large lathes, on which crank-shafts and connecting-rods are turned, we get the material from the steel works already roughed, and when in finishing we let the lathe run at the speeds called for by the fast-cutting steels, in most cases the proportionately long shaft chatters so that a smooth and round surface is not to be obtained. Also, connecting-rods get warm very easily, and twist. For this reason we use in our shops the high-speed steel for finishing only because we have it on hand. In our opinion fast-cutting steel can only be used to advantage for roughing, and on sufficiently strong lathes.

"We are about to try high-speed steel for milling cutters; our experiments are, however, not yet ended. For drills this steel is only practical where there are heavy fast-running machines.

"In general, we believe that at first there was more high-speed steel used than was economical. This is confirmed by the agents of the steel works, who have told us that there is already an over-production, and that the sale of fast-cutting steel is not so heavy as the steel works at first expected."

Fr. Stolzenberg & Co., manufacturers of fine gears, Berlin, say:

"We have the experience in our works, that the different high-speed steels for lathe work and milling are but little suited for finishing, and especially for work with light cuts, because the surfaces obtained thereby look less neat than those obtained with tools of the ordinary quality of steel. For roughing out, where the appearance of the surfaces worked makes no difference, these steels offer, naturally, great advantages."

It is to be remembered that Mr. Mould told the American Master Mechanics' Association (I quote again from memory) that although high-speed steel costing 65 cents a pound often replaced to advantage low-grade carbon steel at 10 cents, the saving in comparison with ordinary steel at 16 cents was not so great.

In the use of milling cutters and reamers with heavy central portions there is no trouble as regards conducting away the heat, because the central portions are usually of large enough cross-section to carry away all the heat. Here, however, there is a very great inconvenience—too little room for the chips. This is at any rate the case where the usual number of cutting edges is employed. This is, of course, remediable by having fewer cutting edges and more space between them. When the time saved in using the new steels is very short, as is the case where they do not work at the high, that is, the roughing, speeds, the saving by their use is confined to that owing to their greater durability. When the time necessary to do the actual cutting is short in comparison to that required to chuck the pieces, the saving by the use of the new steels is again reduced to little more than that due to their greater durability.

Gledhill says in the *Iron Trade Review* that in many cases the new steels are not so good for finishing cuts as special water-hardening carbon steels. G. M. Campbell, in the *American Machinist*, says that the new steels are not good for light cuts, or for finishing. Becker and Brown say in the *Engineeering Magazine* that a tool of the new steel cuts quite differently from one of carbon steel; it wedges off the material, hence gives rougher surfaces than one of carbon steel. It is certainly the case that the new steels have not shown themselves so good on gray iron as on steel, and that on brass they have not given satisfaction.

The reason why the new steels work better on steel than on cast iron is explained by Corby by the fact that in turning steel with any steel tool, at high cutting speeds, there is formed on the upper side of the tool a hollow, caused by the friction of the turnings. There is also formed on the cutting edge a slight elevation of turned-off metal, welded on the tool by the heat of the work. The deeper the cut, the further the hollow is from the edge. In cutting cast iron this does not take place. So with steel the tool wedges off the material, instead of cutting it, and the point of separation of the turning from the work-piece lies ahead of the cutting edge, instead of directly before it. The heavier the turning, the more the resistance, and the further back it rolls on the tool. The tool splits off material as a wedge splits wood lengthwise, always in advance of the edge.

I think I have given enough instances to prove the correctness of my assertion, that while the new steels are very well adapted to roughing, they are not suited to finishing-cuts on the lathe, nor for milling, which, naturally, is supposed to be an operation delivering finished surfaces.

* * *

The New York and Long Island Railway Company, known as the Belmont or old Steinway Tunnel System, have just awarded a contract to the Otis Elevator Company for the two largest escalators ever built to be installed in the Manhattan terminal of that system at 42d Street, between Lexington and Third Avenues. Trolley cars instead of trains are to be operated in this tunnel and these running on short headway provide a tremendous capacity. It is estimated that the capacity will be at least equal to that of the trains of the present Brooklyn Bridge during rush hours and the escalator equipment above referred to is equal in point of capacity to that of the entire stairway equipment of the Manhattan end of the Brooklyn Bridge. Furthermore, not only will the escalators be sufficient to handle any number of people up to the capacity of the trolley cars of the tunnel but they will also serve to marshall the crowds into streams of people moving uninterruptedly and not coming into conflict with one another. The escalators will provide service between levels something over 55 feet apart and will be arranged side by side. Most of the time one will be operated ascending and the other descending but during the morning rush hour both will be operated ascending.

* * *

The invention of the tapered die for cutting pipe threads, according to the *Valve World*, is that of Mr. T. W. Gates of Chicago. Mr. Gates was a blacksmith and in his work years ago found it very difficult to start a straight-thread die on a bolt, whereupon he hit upon the idea of making the die with a tapered thread, which proved to be a success. The same idea was applied to threading pipe, and in this case gave the additional advantage of a tapered thread, which made for additional safety in getting a tight joint. It is alleged that Mr. Gates collected a royalty on the idea for a number of years, which, perhaps, confirms his claim as an inventor of this idea. However, this idea in common with so many others would seem to be one that would naturally follow the use of solid hand dies that it is difficult to believe that there is any "first" man who can definitely prove his claim to its origin.

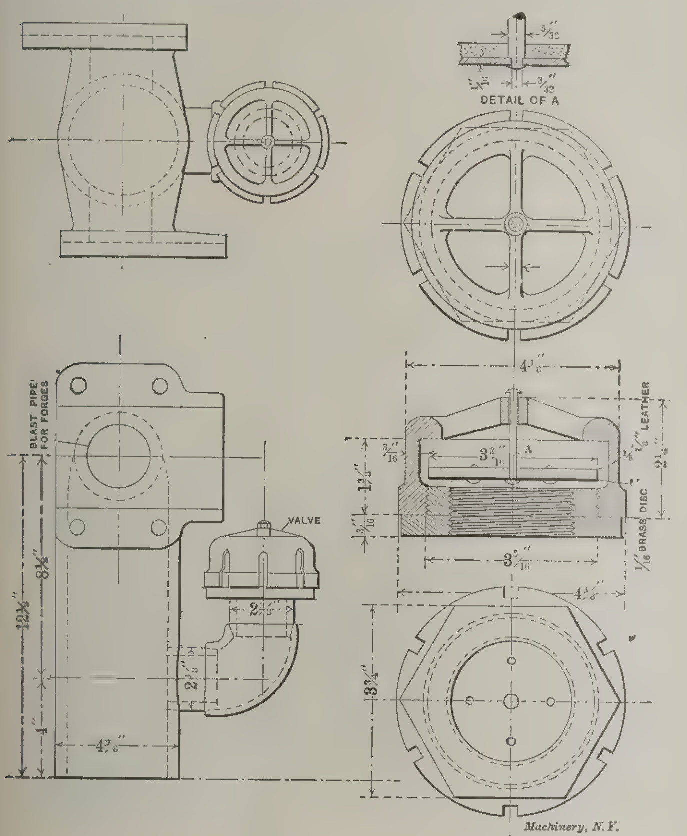
* * *

A thoroughly organized selling department is a vitally important part of every successful manufacturing industry, but it is one of those obvious facts that a "practical" mechanic is very prone to underestimate or ignore when he contemplates starting into manufacturing on his "own hook." To illustrate what selling machinery, even of the heaviest type, costs it may be mentioned that one well-known concern, which is reputed to have the best organized and most efficient selling department in the United States, has found that its selling cost is 18½ per cent of the manufacturing cost.

LETTERS UPON PRACTICAL SUBJECTS.

SAFETY VALVE FOR BLAST PIPES.

In view of the fact that there are and have been so many large modern smith shops erected in recent years, and there have been several cases to my knowledge where said shops have been put entirely out of business by terrific explosions of accumulated gas in the blast pipe, and as "an ounce of prevention, etc.," I submit herewith a design of a safety valve, which is self-explanatory. My sketch shows the valve applied to the upright pipe casting which is commonly used in double forges, although the same may be applied to any form of blast pipe.



Safety Valve for Forge Shop.

It has been found that fires which are left to smoulder during the night emit a great quantity of gas, and the blast fan not running, the piping system forms a natural draft for the gases, which accumulate in the pipes and, no doubt, are ignited by some of the fires in the forges which continue to burn more or less; hence the explosion.

It will be noticed that this valve, if placed as shown, will allow the gases to escape, as the leather-seated disk valve will drop or unseat as soon as the blast fan stops or the pressure is off the under side of valve. My attention has been called to the fact that just recently two explosions of this kind occurred. In one case a large blast fan and its entire pipe connections were completely ruined by a terrific explosion of this kind and the whole shop put out of business for several days. To a practical man the necessity of an immediate installation of something of this kind, if the question has not already been considered, is most apparent. ALBERT P. SHARP.

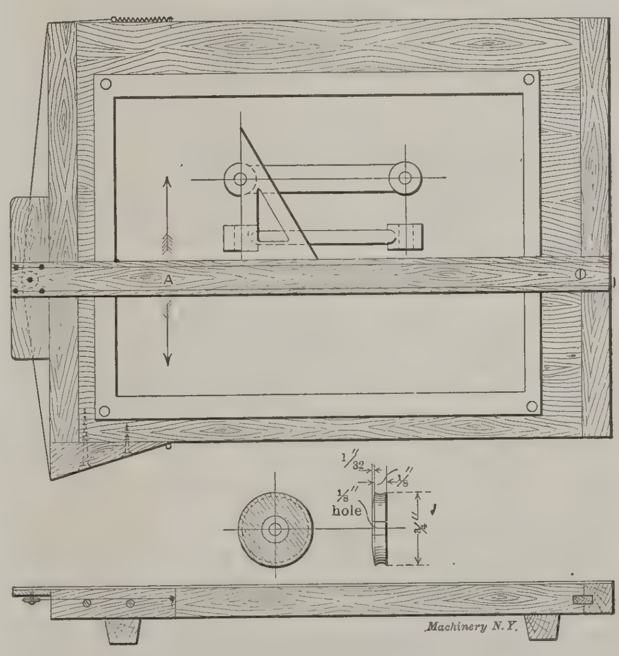
Williamsport, Pa.

ARRANGEMENT FOR HOLDING T-SQUARE IN PLACE.

The accompanying cut shows a very simple, cheap and effective arrangement for holding the T-square against the edge of the drawing board. The materials needed are a small wooden grooved wheel, a sufficient length of heavy cord about 3/32 inch in diameter, a coiled spring to give sufficient tension to the cord, and a few screws, all arranged as shown in the cut. A strong rubber band can be used in place of the spring but of course is short-lived. The wheel is fastened in the center of the under side of the T-square head. On small boards it may be advisable to fasten a small triangular block at the lower left hand corner of the board so as to allow the T-square to be used when the drawing is near the edge of the board.

To one accustomed to the old method of moving the T-square by grasping the head and continually lining it up, the advantage of this simple device will be a surprise, as the T-square can be moved easily by applying the hand at *A*, about eight inches from the head, and when moved out of line it automatically returns to its proper place. I often have persons come to my board to inspect a drawing. Naturally they try to push the T-square out of the way. Imagine the surprise when the T-square swings around quickly into place again like a live thing.

An important advantage is, that in keeping the head snug against the edge of the board, the wear on the ends of the head where it slides on the board is avoided. This wear is caused on the ordinary T-square by the uneven pressure when sliding it up and down. The edge gradually becomes slightly curved, resulting in non-parallel lines on the drawing. Most draftsmen are not aware of this defect. The T-square is quickly detached by simply lifting it off the board, the cord slipping easily from the wheel. To find the proper tension for the cord, the T-square should be put in the center of the board, the cord fastened to the lower edge of board and brought around the wheel to a loop in the end of the spring which is fastened at the upper edge of the board. Now swing the T-square around so that it lies on an angle of about 30 degrees to the center, keeping one end of the head against the edge and near the center of the board. Increase the tension on cord until it is sufficient to cause the blade to swing quickly into place. In other words it should be so tensioned



Arrangement for Holding T-square in Place.

that no matter in what position the T-square is left, it will immediately return to proper position. This scheme can be applied to any common T-square up to 42 inches long. The writer has used a 42-inch T-square for some time. Of course it is preferable to use as light a T-square as possible. Note that the cord is not wound around the wheel, but simply bears on it exactly as a trolley wire on the trolley wheel.

S. J. B.

ON THE OBJECT OF TECHNICAL TRAINING.

When I see anything like the extract from the paper of Mr. Thomas Hill which you presented on page 81 of the October issue (Engineering Edition) it sets me first to boiling over and then to thinking. I have no wish to champion

technical schools nor any particular technical school for anything other than what it is and what it does. My connection with the school of which he apparently writes was of such short duration as to give me absolutely no right to speak for it with authority, but I cannot see you present even another person's views written in so unjust a fashion without a protest. For Mr. Hill to say that any technical graduate "is given a diploma, signifying he has nothing more to learn," etc., is a rank outrage. It ought to deceive no one but it will if allowed to pass unnoticed, without a doubt be the turning point in some young man's career. And if even one young man, discouraged by your repetition of Mr. Hill's statement, may be persuaded to stop and reconsider then my efforts will be well paid.

Suppose that every statement alleged by Mr. Hill were true. What then? It shows that some young man had spent three or four days doing a job whose commercial value was nil. But during the intervening time this young man had doubtless also covered numerous sheets of paper with worthless figures and had burnt untold cubic feet of gas of a distinct commercial value to learn various things having a rather distant relation to drafting. And what had the young man learned while he was spending these three or four days making this worthless bit of material? He learned to hold a hammer and a chisel, to hold a file, to use patience. He learned to know how little difference there is between a good fit and a loose one or no fit at all. He had that invaluable experience for any man. *He had been compelled to stick to a job till he did it well.* How many men have spent three or four years instead of three or four days learning that simple thing? For my own part I freely admit that I consider it much better to take a green hand and start him right into the middle of things, but you cannot persuade many men, either in or out of the shop, that this can be done. It is astonishing even to those who are in daily touch with students how fast they develop and how quickly they grasp things that in the ordinary shop they would not be allowed to touch till they had worked a great deal longer time than the "tech boys'" whole shop course. Time and cost are essentials but not all the essentials of production as I know to my sorrow. My father had an idea like Mr. Hill's. He believed that time was the one essential. He taught me to do what was set before me promptly, and do it quick. No matter how it was done if it was only done in a hurry. He thought that thoroughness would come later. But it never did. And it cannot be expected to. Of all things, boys, learn to do what you do well. You can learn to do things quickly and well only when you can do them as a matter of habit. You cannot afford to pay tuition to any school while you are learning to do things quickly as well as thoroughly because there are plenty of shops that will gladly pay you living wages to do it their way, and this in spite of the fact that the superintendents of these very shops may unthinkingly condemn the way you were trained. If they say anything to you just ask them what they are doing to get their own apprentices over the road and they will take to the woods in a hurry. If you want to go to some technical school where less stress is put on hand work and more on machine work, there are a plenty of them. See the articles which Mr. Fairfield of the Worcester Polytechnic had on machining simple machine parts if you want an idea of what is done there. There are others, too. But if you do go to one of these other schools do remember that your shop work as well as your other school work is only a foundation on which to build. That is all that any school can do for you. And when you build on this foundation and the shrubbery and the moss grow up around it and hide it from view, don't forget that that is what is holding you up.

"ENTROPY."

DOES STEEL CRYSTALLIZE?

In a short note which appeared in the Engineering Review section of the December issue of MACHINERY, Mr. James H. Baker claims that there is no such thing as the crystallization of steel by shock or vibration. He claims that where cases occur in which crystallization is suspected they simply reduce themselves to defects that have existed in the steel from the beginning. I cannot agree with him for in my experience there is no room for doubt as to the numerous cases of crystallization. For example, I have replaced steel shafting which would repeatedly break at the same place each time, and the breaks would show crystallization or separation of the faces of the crystals. I do not think that the test given by Mr. Baker—that of hammering and bending by a press—is fair, inasmuch as crystallization is brought about by thousands of shocks or bends which in many cases may extend for a period of several years.

L. A. WHEAT.

Battle Creek, Mich.

PORTABLE DRILL SUPPORT.

In building machines which are not made in large enough quantities to warrant the expense of a full equipment of drilling jigs, it quite frequently is necessary that a number of holes be drilled while assembling various brackets. It is then found inconvenient to use a power radial drilling machine and usually the air or electric portable hand drill is utilized. Under ordinary methods, when the diameter of hole to be drilled is over 5/16 of an inch in diameter, it is considered a rather hard and unpleasant job to both support and feed the drill into the work. The accompanying cuts, Figs. 1 and 2, give a general idea of a supporting device for hand drilling which is used quite extensively in one of the large eastern tool building shops and has been found a very satisfactory arrangement.

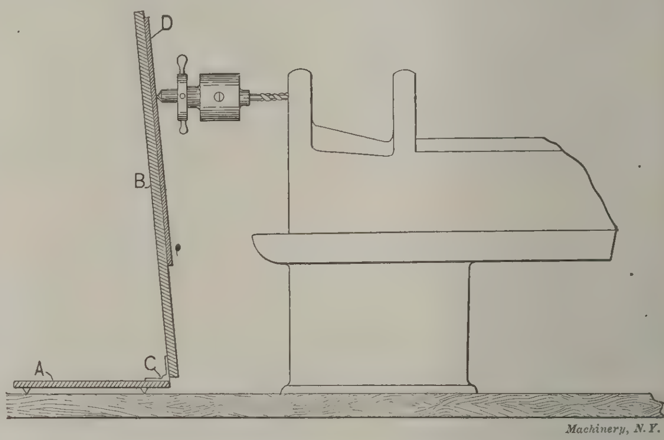


Fig. 1. Portable Drill Support in Use.

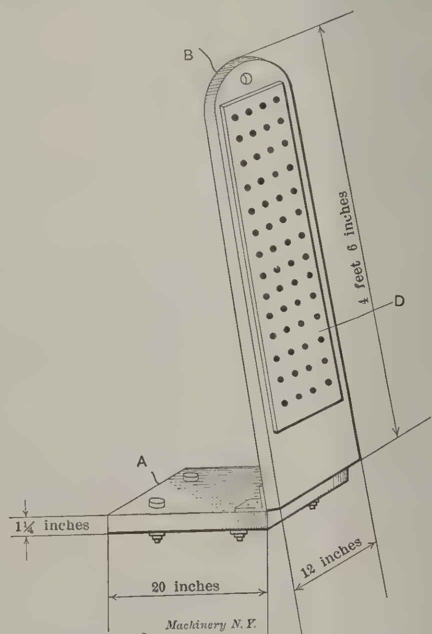


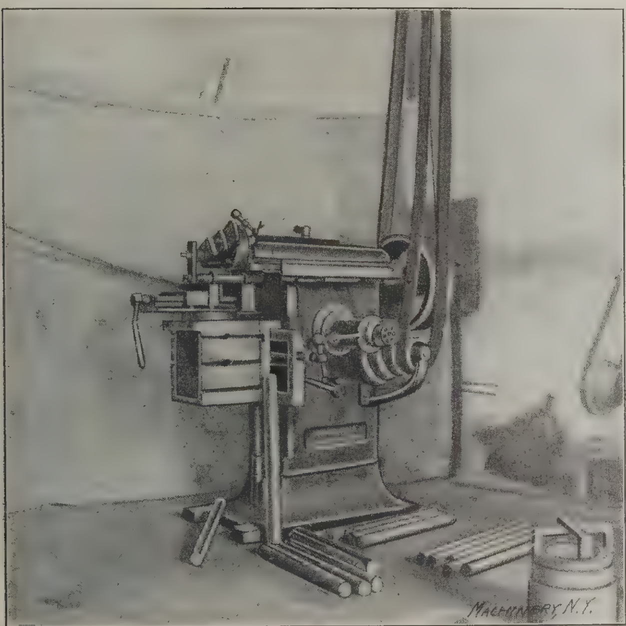
Fig. 2. Detail of Support for Portable Drills.

The support is "made up" of two main parts—a base, *A*, and a swinging upright, *B*. These two members are joined by heavy hinges, *C*. The base has four projecting lugs on its under-side which are sharp enough to slightly sink into the

floor when the workman stands on the base. When in use the outer end of drilling apparatus is located in one of the many center holes in the steel plate D, the center hole selected being one approximately in line with the hole to be drilled. The workman forces the drill into the work by bringing the weight of his body against the swinging upright B. This may seem rather crude but in actual use the lack of "gracefulness" is more than balanced by the ease of manipulation. In drilling holes over 1⅛ inch in diameter, the screw feed is used for feeding, and in this case a sling is thrown over the top of upright B and the work, this simply preventing any backward movements of the upright. C. L. G.

MILLING ATTACHMENT FOR THE SHAPER.

The accompanying halftone shows a milling attachment, adapted for the shaper, and intended for milling keyseats in shafts 2 inches diameter by 24 inches long. The keyway is milled to a depth of 3/16 inch by ⅜ inch wide the full length of the shaft. The time required for milling each shaft is about 45 minutes. Some of the finished pieces will be seen on the floor beneath the shaper. As the shaper is a very old style one, there was barely 1⅛ inch between the rocker head



Milling Attachment for the Shaper.

and the inside wall of the shaper, which made the design of the attachment more difficult. The end thrust is taken up by removing the toolpost and screwing in a shoulder stud to which a clamp is fitted with a set screw provided with a lock nut, the attachment being similar to that of a regular milling machine. This arrangement is shown in the cut. The cutter is driven directly from the countershaft by a wooden pulley on the rear end of the spindle.

San Antonio, Texas. LEO DE HYMEL.

TO FIND THE RADIUS OF AN ARC WHEN THE LENGTH OF THE CHORD AND THE HEIGHT OF THE ARC ARE GIVEN.

In the November issue Mr. Falk gives a description of how "to find the radius of an arc when the length of the chord and the height of the arc are given." I send you herewith a formula for the same, which, perhaps, is somewhat plainer.

$A =$ the height of chord,
$B =$ half the length of chord,
$R =$ radius of arc.

Then $R = \dfrac{A^2 + B^2}{2A}$.

Stockholm, Sweden. J. LUNDIN.

[One or two other correspondents have called attention to what they consider the ungainly form in which this formula appears in Mr. Falk's contribution. There is something, however, to be said in his defense, and the matter is of enough importance to warrant a few words.

The most compact and concise arrangement of which a formula is capable is not necessarily the easiest one to use in practice. Let us take the example, for instance, of an arc whose chord is 1.47 long and whose height is 0.38. Let it be required to find the radius of the arc. Mr. Falk's formula is:

$$R = \frac{\dfrac{\left(\dfrac{L}{2}\right)^2}{H} + H}{2} \qquad (1)$$

Mr. Lundin's formula changed to correspond to the problem as stated by Mr. Falk is:

$$R = \frac{\left(\dfrac{L}{2}\right)^2 + H^2}{2H} \qquad (2)$$

It will be noted that the length, not half the length, of the chord, is given, thus necessitating the change. For values of L and H just taken we have solved both equations 1 and 2 in the example below, using as few figures as possible and carrying the answer out to the third decimal place in each case.

Equation 1.

```
1.47
 .735
 .735
------
  3675
 2205
5145
------
.540225  ( .38
38         ------
------     1.422
 160        38
 152       ------
------     1.802
  82
  76       .901 = R.
------
  62
```

Equation 2.

```
       1.47
        .735
        .735
      ------
         3675
        2205
       5145
      ------
      .540225
         .38
         .38
        ------
         304
        114
        ------
 .38    .1444
   2    .540225
 ----   -------
 .76)   .684625  (.901 = R
        684
        -------
          62
```

It will be noticed that Mr. Falk's more complex formula requires 56 figures while the simpler formula requires 66, and there is a corresponding saving of time with the first way of doing it. The reason is clearly seen. The original form of the equation gives a consecutive calculation. The second form requires first, the squaring of $\dfrac{L}{2}$, then the squaring of H, and and then the addition to it of the previous result before we can complete the problem. The first method will be found much the easier of the two to use in practice. We are willing to admit, however, that it might better have been given for the diameter, and taken the form:

$$D = \frac{\left(\dfrac{L}{2}\right)^2}{H} + H$$

If it were a question of remembering the formulas, there would be no comparison. Mr. Lundin's arrangement is superior. But it is foolish to try to remember too many formulas; they should be kept where they are easily available and may be referred to when necessary. In deriving a formula and arranging it for practical use, it is much better to put it in a form that will allow a consecutive calculation from beginning to end, where possible, than it is to try to give it the simplest *looking* arrangement as it appears on the printed page.—EDITOR.]

MAKING TAPER PINS BY PUNCHING.

Recently I had occasion to decide how to make, and to design the tools for making several thousand pounds of special taper pins from cold-rolled steel to be used as parts of special machines. The first thought was to turn them in an automatic screw machine with tools of customary design for such work. But instead of the screw machine we decided to try the punch press; after some experimenting, pins of satisfac-

tory dimensions, and sufficiently smooth to be acceptable for the purpose, were turned out. The cost of production in the press was about fifty per cent below what we figured it would be in the screw machine, and less stock was used than if we had adopted the latter way of doing this work. No loss by turning off the stock is required when making the pins in this way. After the length of the blanks was determined by experiment we cut them up in a cutting-off machine and then literally punched them to size.

The cuts show an elevation and plan of the punch and die. Fig. 1 is the die, consisting of the steel holder *A*, cast extra thick to withstand any tendency to flexture, and the die proper, *B*, made of tool steel and as hard as fire and water will allow, and not drawn. After hardening, the taper hole was lapped very smooth to minimize friction and permit of easier stripping of the pins. Two sections of the hole in *B* are made straight; the upper part receives the work and holds it in a

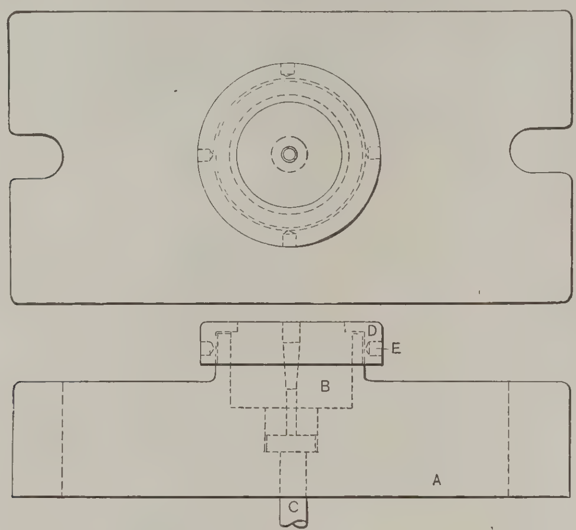


Fig. 1

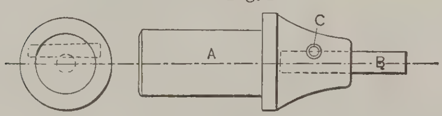


Fig. 2 *Machinery, N.Y.*

Making Taper Pins by Punching.

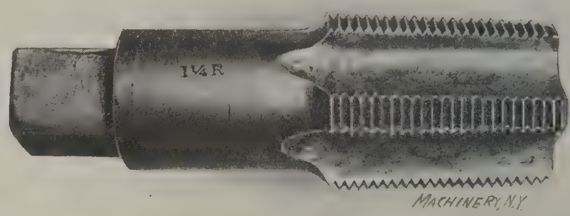
vertical position so that the end may come directly in contact with the end of the punch on the down stroke. The lower section is also straight, and to it is fitted the upper end of ejector *C*, which is caused to slide up and down by a lifting device connected to the ram of the press. This lifts the work on the up stroke of the press ram to a sufficient height to be conveniently removed by the operator. The die is seated in the holder and retained there by the cap *D*, which is screwed tightly to holder *A*. Four holes, *E*, equidistant are for inserting a piece of drill rod to tighten the cap. The parts that constitute the punch, Fig. 2, are holder *A*, the punch *B* made from drill rod and hardened, and the taper pin *C* holding the punch in place.

In conclusion it may be pointed out—though it is perhaps so obvious as scarcely to need it—that taper pins may be made in the punch press longer than the one shown in the illustration and of more taper, the limit of the latter condition being governed by the ductility of the metal and the pressure applied. ENGINEER.

THREADING WROUGHT IRON VS. CAST IRON.

The accompanying cut shows a 1¼-inch pipe tap which up to the time of photographing, had tapped 10,000 pieces of malleable iron parts and 10,000 pieces of cast iron. All the pieces were ¾ inch thick, thus making 15,000 lineal inches or 1,250 feet of metal tapped, and the tap is "just as good as new"; if it had worn any below size it could not be used as the parts tapped are used in automobile construction which means a vastly different requirement from the indifferent fits of common wrought iron nuts. This same tap would go on tapping wrought iron for years and perhaps would tap a million of wrought iron nuts. Comparing wrought iron to cast iron and malleable iron to brass, in regard to wearing out a tool, is in my opinion absurd.

The lower the heat we can harden a tool of any kind at, the better it is for the tool; for instance, I would harden a tap for tapping wrought iron nuts at a very low heat, thereby getting a fine grain, but this tap would not hold up to size very long if put to work on cast iron or malleable iron because it would not be hard enough. I always find out what is required of a tap or tool of any kind before I put it in



Tap with Good Record.

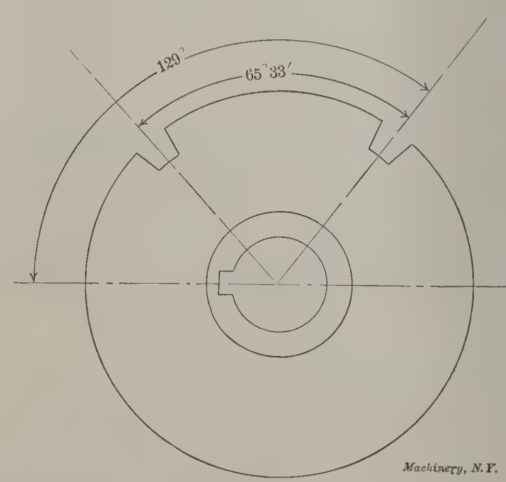
the fire and then temper accordingly. So a tap that I would temper for wrought iron nuts would be too soft to stand the wear for any great length of time if used on harder metals. About the only way I ever saw "boughten" taps give out is to break in pieces, because they are just as hard inside as they are on the cutting edge. What we want in a tap is toughness in the body of the tap and the teeth just hard enough to stand the wear of the metal it is to be used on. The tap shown here was heated in a charcoal fire covered completely, and at a very low heat, with blast shut off. It was dipped in cold salt water just long enough to harden the teeth, then the tap was put in fish-oil and let remain there until cold.

The teeth on a tap will harden at a very low heat, and the lower the heat the better for the tap. If interested in first-class tempering, experiment on an old broken tap and see at how low a heat it will harden. I am not at all surprised at the number of broken tools seen in some shops considering the heat they are dipped at; the grain in them looks like cast iron. They cannot be anything else than brittle, and bear in mind that drawing to a color will not restore the grain. J. F. SALLOWS.

Lansing, Mich.

OBTAINING DEFINITE ANGULAR MOVEMENTS BY THE INDEX HEAD.

The job herewith described and illustrated came my way some time ago, and as it seems to be of more or less usual occurrence, I hope that it will be of interest to others in the



Example of Angles Obtained by the Index Head.

toolmaking business. The job consisted of fourteen division plates for a milling fixture—I give one as typical. The cut shows the plate and gives all the necessary information. The way I figured out the moves on the dividing head was as

follows: The circumference of the circle being 360 degrees, and there being 40 teeth in the worm wheel of the head, it follows: $\frac{360}{40} = 9$ = number of degrees for one revolution of the worm; therefore $\frac{129}{9} = 14\ 3/9$ = number of revolutions of the worm for 129 degrees, or 14 6/18 revolutions is the correct move.

The move for the second notch is compounded: $\frac{65}{9} = 7\ 2/9$ = number of revolutions for 65 degrees, and this expressed in form of a working number = 7 6/27.

TABLE OF MOVES FOR OBTAINING ANGLES WITH THE BROWN & SHARPE INDEX HEAD.

Angles, Deg.	Move, Revs.	Angles, Deg.	Move, Revs.	Angles, Deg.	Move, Revs.	Angles, Deg.	Move, Revs.
1	2/18	1 1/3	4/27	1 1/2	3/18	1 2/3	5/27
2	4/18	2 1/3	7/27	2 1/2	5/18	2 2/3	8/27
3	6/18	3 1/3	10/27	3 1/2	7/18	3 2/3	11/27
4	8/18	4 1/3	13/27	4 1/2	9/18	4 2/3	14/27
5	10/18	5 1/3	16/27	5 1/2	11/18	5 2/3	17/27
6	12/18	6 1/3	19/27	6 1/2	13/18	6 2/3	20/27
7	14/18	7 1/3	22/27	7 1/2	15/18	7 2/3	23/27
8	16/18	8 1/3	25/27	8 1/2	17/18	8 2/3	26/27
9	1	9 1/3	1 1/27	9 1/2	1 1/18	9 2/3	1 2/27
10	1 2/18	10 1/3	1 4/27	10 1/2	1 3/18	10 2/3	1 5/27
11	1 4/18	11 1/3	1 7/27	11 1/2	1 5/18	11 2/3	1 8/27
12	1 6/18	12 1/3	1 10/27	12 1/2	1 7/18	12 2/3	1 11/27
13	1 8/18	13 1/3	1 13/27	13 1/2	1 9/18	13 2/3	1 14/27
14	1 10/18	14 1/3	1 16/27	14 1/2	1 11/18	14 2/3	1 17/27
15	1 12/18	15 1/3	1 19/27	15 1/2	1 13/18	15 2/3	1 20/27
16	1 14/18	16 1/3	1 22/27	16 1/2	1 15/18	16 2/3	1 23/27
17	1 16/18	17 1/3	1 25/27	17 1/2	1 17/18	17 2/3	1 26/27
18	2	18 1/3	2 1/27	18 1/2	2 1/18	18 2/3	2 2/27
19	2 2/18	19 1/3	2 4/27	19 1/2	2 3/18	19 2/3	2 5/27
20	2 4/18	20 1/3	2 7/27	20 1/2	2 5/18	20 2/3	2 8/27
21	2 6/18	21 1/3	2 10/27	21 1/2	2 7/18	21 2/3	2 11/27
22	2 8/18	22 1/3	2 13/27	22 1/2	2 9/18	22 2/3	2 14/27
23	2 10/18	23 1/3	2 16/27	23 1/2	2 11/18	23 2/3	2 17/27
24	2 12/18	24 1/3	2 19/27	24 1/2	2 13/18	24 2/3	2 20/27
25	2 14/18	25 1/3	2 22/27	25 1/2	2 15/18	25 2/3	2 23/27
26	2 16/18	26 1/3	2 25/27	26 1/2	2 17/18	26 2/3	2 26/27
27	3	27 1/3	3 1/27	27 1/2	3 1/18	27 2/3	3 2/27
28	3 2/18	28 1/3	3 4/27	28 1/2	3 3/18	28 2/3	3 5/27
29	3 4/18	29 1/3	3 7/27	29 1/2	3 5/18	29 2/3	3 8/27
30	3 6/18	30 1/3	3 10/27	30 1/2	3 7/18	30 2/3	3 11/27
31	3 8/18	31 1/3	3 13/27	31 1/2	3 9/18	31 2/3	3 14/24
32	3 10/18	32 1/3	3 16/27	32 1/2	3 11/18	32 2/3	3 17/27
33	3 12/18	33 1/3	3 19/27	33 1/2	3 13/18	33 2/3	3 20/27
34	3 14/18	34 1/3	3 22/27	34 1/2	3 15/18	34 2/3	3 23/27
35	3 16/18	35 1/3	3 25/27	35 1/2	3 17/18	35 2/3	3 26/27
36	4	36 1/3	4 1/27	36 1/2	4 1/18	36 2/3	4 2/27
37	4 2/18	37 1/3	4 4/27	37 1/2	4 3/18	37 2/3	4 5/27
38	4 4/13	38 1/3	4 7/27	38 1/2	4 5/13	38 2/3	4 8/27
39	4 6/18	39 1/3	4 10/27	39 1/2	4 7/18	39 2/3	4 11/27
40	4 8/18	40 1/3	4 13/27	40 1/2	4 9/18	40 2/2	4 14/27
41	4 10/18	41 1/3	4 16/27	41 1/2	4 11/18	41 2/3	4 17/27
42	4 12/18	42 1/3	4 19/27	42 1/2	4 13/18	42 2/3	4 20/27
43	4 14/18	43 1/3	4 22/27	43 1/2	4 15/18	43 2/3	4 23/27
44	4 16/18	44 1/3	4 25/27	44 1/2	4 17/18	44 2/3	4 26/27
45	5	...	...	...	...	...	...

ANGULAR VALUES OF ONE-HOLE MOVES ON BROWN & SHARPE INDEX PLATES.

15 hole circle = 36. minutes.	29 hole circle = 18.620 minutes.
16 " " = 33.750 "	31 " " = 17.419 "
17 " " = 31.788 "	33 " " = 16.363 "
18 " " = 30 "	37 " " = 14.594 "
19 " " = 28.421 "	39 " " = 13.846 "
20 " " = 27 "	41 " " = 13.170 "
21 " " = 25.714 "	47 " " = 11.489 "
23 " " = 23.478 "	49 " " = 11.020 "
27 " " = 20 "	

In calculating the angular values of one-hole moves, I found that 1/33 revolution of the worm = 16.363 minutes, and this number multiplied by 2 = 32.726 minutes. This was considered "good enough" and accordingly the move 7 6/27 + 2/33 was taken. The error resulting was 0.274 minutes and this reduced to linear measurement on a diameter of 6 inches = 0.00023 inch, which was in this case a negligible quantity.

A table is appended giving the number of revolutions for different number of degrees. In the column for the "move," the whole number, where given, indicates the number of revolutions, the numerator the number of holes additional, and the denominator the number of holes in the index circle to be used. A table is also given stating the angular movement of index head for movements of one space in various index circles.

Auburn, N. Y. JOHN PRICE.

WIRE CUTTER, LATHE CHUCK AND PLANER JACK.

The accompanying cuts show three old but very useful tools. Fig. 1 is a wire cutter; the principal dimensions given are suitable for a machine to cut off 7-16-inch diameter mild steel.

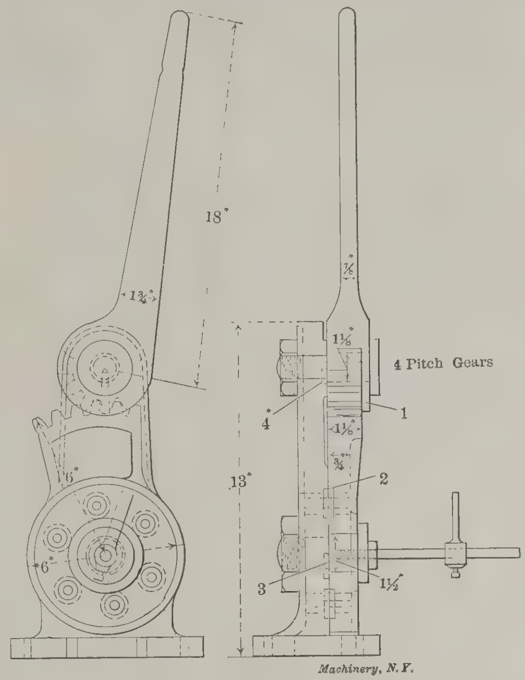


Fig. 1. Wire Cutter.

The pinion is shrouded as shown at (1); the cutters or bushings are, of course, made of tool steel and hardened. We have been in the habit of putting washers of tin behind the shoulder at (2) when the cutter became dull and then grinding flush, although no doubt this could be improved upon. At (3) and (4) are shown pin keys which key the studs from turning while assembling.

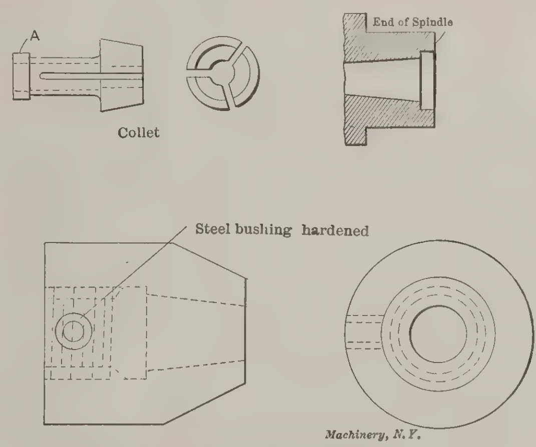


Fig. 2. Lathe Chuck for Screw Machine Collets.

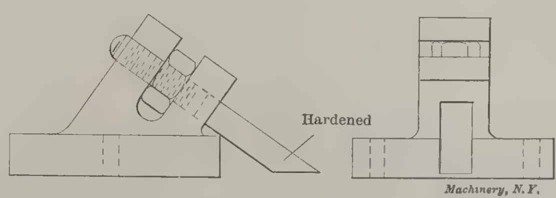


Fig. 3. Planer Jack.

Fig. 2 is a chuck to fit the engine lathe to permit the use of the spring collets for the screw machine. All that is necessary is the mild steel chuck and a spanner wrench, and to bore

a recess into the spindle of the lathe about 3-16 inch deep so that the part *A* of the collet will enter freely, but without play. I always use, wherever possible, a hardened steel bushing for the spanner hole.

Fig. 3 is a pinching down jack for the planer. It is much better than the ordinary loose piece and screw stud, especially when taking a finishing cut after relieving the strain, as there is no danger of the whole thing being thrown out or becoming loose by the terrible reversing shocks of some old planers. J. T.

A WAY OF ARRANGING A COUNTERSHAFT FOR A LARGE PLANER.

The accompanying cuts show an ingenious way of arranging a countershaft for a large planer. The planer is placed in the middle of a large bay in which is a traveling crane.

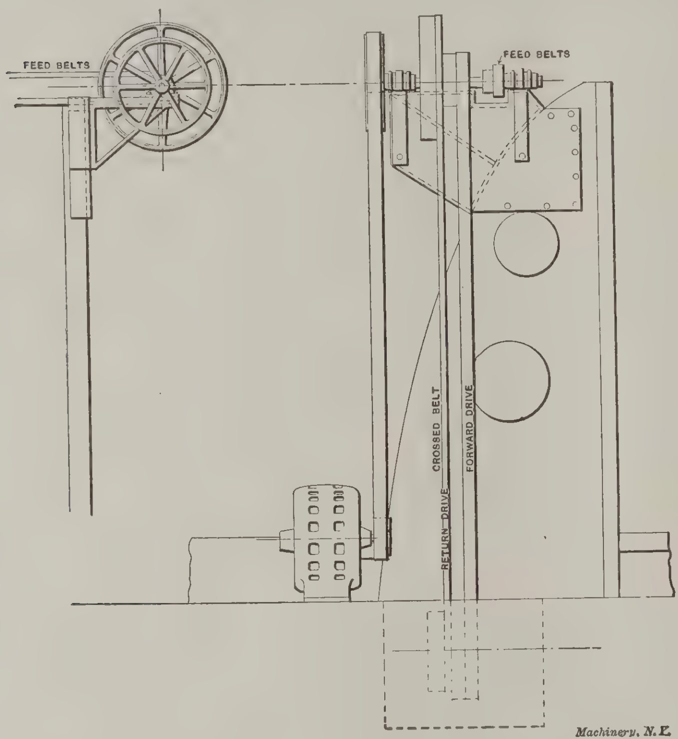


Fig. 1. The Countershaft in Place.

There are no timbers or trusses available on which to hang the countershaft. As there also is no room on the floor to set up the countershaft, it was finally decided to fasten a large bracket to the housing of the planer and attach brackets for the bearing boxes on this. Fig. 1 shows the way this was done and Fig. 2 shows the bracket in detail. Chipping strips are provided where the casting fits on the curved surface of the frame, and the cut shows the manner in which it was bolted on. The motor sets up close to the machine and the drive belt

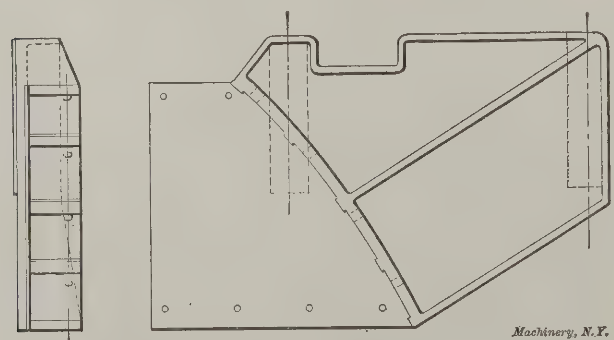


Fig. 2. Detail of Countershaft Bracket.

passes up to the countershaft on which are located the forward and return drives and two pulleys for tool feed. Directly underneath is a pit in which are the tight and loose pulleys for operating the planer bed. The machine has been in operation for over a year and works well. The bracket is very rigid and is at a sufficient elevation to allow the largest piece that can pass through the housing of the planer to pass under the cross belts which give the vertical and cross feeds. The bracket is about 6 feet long and the countershaft sets about 16 feet above the floor. EDWARD BALBACH.

Dayton, Ohio.

USING DECIMAL EQUIVALENTS INSTEAD OF COMMON FRACTIONS.

It seems to be the general impression that it is easier and quicker to use the decimal equivalent of a fraction, instead of the fraction itself, when engaged in any calculations where the quantities occurring have to be multiplied or divided. There are very few cases, however, where the calculation can be made simpler by this substitution, and the results obtained are invariably less correct, because all the decimals which are necessary to correctly express the value of the fraction are as a rule not used, and when multiplying, an original error in the decimal equivalent substituted, of only one-half or one-quarter of one-thousandth inch, may finally amount to so many thousandths as to cause serious errors in close work.

An example which will plainly illustrate this assertion, and vindicate the position taken, may be found in the article "Jack Makes a Formula" in the December issue of MACHINERY. "Jack" writes his formula with figures substituted for the letters

$$R = \frac{0.687^2 + (1.5 - 0.75)1.5}{2(0.687 - 0.375)}$$

Proceeding he finds

$$R = \frac{0.472 + 1.125}{0.624} = \frac{1.597}{0.624} = 2.559.$$

If instead of using decimal equivalents for the fraction originally given in the problem we use the fractions themselves, we would write

$$R = \frac{\left(\frac{11}{16}\right)^2 + \left(1\frac{1}{2} - \frac{3}{4}\right)1\frac{1}{2}}{2\left(\frac{11}{16} - \frac{3}{8}\right)}$$

Simplifying this expression we find

$$R = \frac{\frac{121}{256} + 1\frac{1}{8}}{\frac{5}{8}} = \frac{\frac{121}{32} + 9}{5} = \frac{409}{160} = 2.556$$

We notice in the first place that "Jack's" denominator 0.624 ought to have been 0.625 or ⅝, and further, the final result shows a difference of 0.003 inch, which is enough to spoil many a job which may not even be required to be of extreme accuracy. This error is all due to the seemingly small original error of writing 0.687 instead of 0.6875.

Whenever there are no special reasons for using the decimal equivalent for a common fraction, the use of the fraction itself for calculations will always insure a correct result, besides usually decreasing the number of figures necessary to handle. Both draftsmen and machinists are always very eager to substitute the equivalents. If they would accustom themselves to using the fractions directly there would be fewer cases in the shop of deviation between the figured result and the measured. There is no good reason for substitution, and probably the only reason that can be advanced is that figuring with decimal fractions resembles the figuring with whole numbers, and consequently is easier. The actual amount of work, however, is usually increased, and accuracy is sacrificed for convenience. R. S.

* * *

GRAPHITE SUGGESTED IN PLACE OF CHARCOAL.

In the January issue of MACHINERY Mr. U. Peters describes a method of coating iron with copper. We suggest that inasmuch as graphite can be powdered more finely than charcoal and that it lies closer to the metal, thereby making a much better coating, it might prove to be far superior to powdered charcoal in the process mentioned by him.

THE JOSEPH DIXON CRUCIBLE CO.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.
Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

DRIVING SCREW EYES.

The best way of which I know to drive or remove screw eyes, screw hooks, or the like, is the ordinary brace, and especially one made for the German flat-shanked bits. They drive straight and hard. ROBERT GRIMSHAW.

Hanover, Germany.

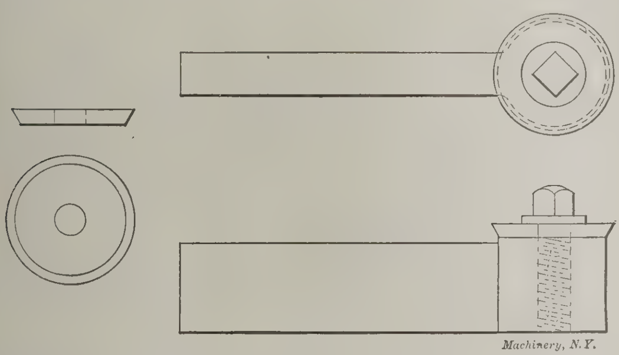
PEEP HOLES FOR ANNEALING FURNACES.

No annealing furnace should be unprovided with suitably placed peep-holes, properly protected with mica; for although the eye can by no means determine the temperature of the work with sufficient accuracy to be depended upon alone, yet a comparative observation can be made and the observer can readily tell if some pieces are in danger of being overheated, while others on the contrary have not yet got hot enough. Where there are peep-holes, and they are properly made use of, the amount of unequally heated and cracked pieces will be materially diminished. ROBERT GRIMSHAW.

Hanover, Germany.

RADIUS TURNING TOOL.

The cut below shows a simple radius turning tool and holder. The side view shows the cutter with a setscrew holding same in position, and clamping it to the body. The tool must be slightly larger than the circular part of the holder so as to give some clearance. The circular end of the body

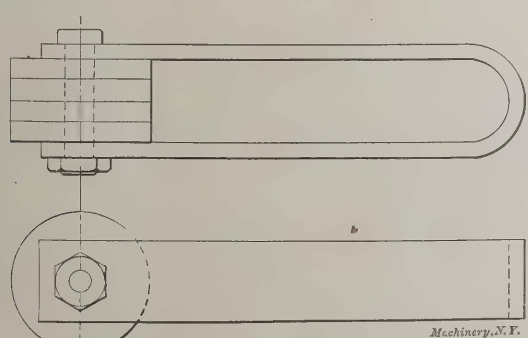


adds greatly to the strength of the tool and is also a preventative of chattering. In the detail of the cutter the clearance is shown exaggerated. These cutters may be turned, drilled and cut from a tool steel bar while held in a chuck. They are then hardened and the cutting surface ground.

Covington, Ky. FRANK LANG.

EMERY WHEEL DRESSER.

The cut below shows a simple emery wheel dresser made from an ordinary bent piece of band iron with four or five tool steel washers between the ends. A small bolt passes through the washers and the band iron holding it together. If the

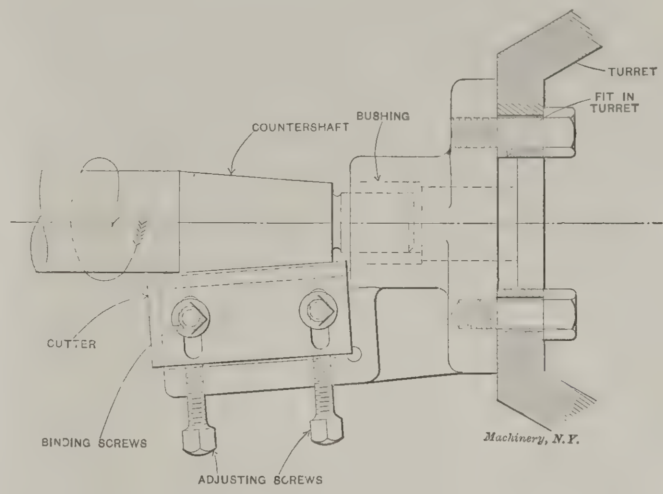


wheels of an ordinary dresser are worn out ordinary tool steel washers may be inserted as these will last just as long and are a great deal cheaper than the wheels bought especially for the purpose. ROY B. DEMMING.

Geneva, N. Y.

TURRET TOOL FOR CUTTING TAPERS IN THE SCREW MACHINE.

The cut herewith shows the way in which I recently machined the taper on 250 automobile countershafts. The tool

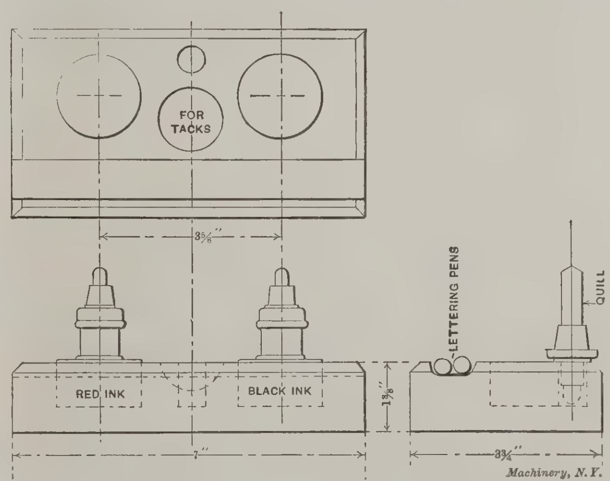


gave good satisfaction. It can be adjusted to almost any taper desired. C. W. PUTNAM.

New York City.

SAFEGUARD FOR INK BOTTLES.

In the December issue of MACHINERY, Mr. Lachmann writes about "A Simple Safeguard for Ink Bottles," which is all right, but could be improved upon without the use of mucilage. Taking the cardboard, describe a circle on it about ⅛ inch larger than the bottle, divide the circle into eight parts, draw lines from these points to within 3-16 inch of the center; then run your knife through those lines and lift up every other piece of paper to the edge of the circle and put an elastic band around the pieces just lifted up. This will form a wall around your bottle, while the pieces which stay down form a good base. Some readers will probably remember doing this in their school days. A better safeguard and a more substantial one is the one shown in the sketch; we use them in our office and find them very useful. Take a block



of wood about 3¾ x 7 inches and 1⅜ inch thick; have two holes bored in it part way, one at each end, to fit the ink bottles; also make a ½-inch hole for the quill; this will be found very convenient when lettering. Make a cup-shaped hole at a convenient place to put tacks into and on one side make a groove about ¾ inch wide to lay the lettering pens into; this completes our inkstand. It can be made at very small cost and gives a neat appearance. PETER PLANTINGA.

Worcester, Mass.

INKING ON TRACING CLOTH.

When using the smooth side of tracing cloth an excellent powdered preparation, necessarily applied before inking, is talc, which can be had for almost nothing, it being a fine sand powder used in core work. An old talcum powder box will serve the purpose of a sifter. CALVIN B. ROSS.

Springfield, O.

SHOP RECEIPTS AND FORMULAS.

A DEPARTMENT FOR USEFUL MIXTURES.

This page is intended to be used only for the publication of such shop receipts as the contributors know from experience to be practicable. Receipts are solicited on the condition that the contributors personally know that they are reliable. The fact that a receipt is old and supposedly well-known does not bar it provided it has not already appeared here.

296. FILLING FOR BLOW HOLES IN CAST IRON.

One part red lead, and 1½ part litharge. Mix with glycerine to consistency desired. E. H. McClintock.

West Somerville, Mass.

297. CLEANING THE POLISHED PARTS OF MACHINERY.

Stains of every description, such as may result from dried oil, etc., may be easily and effectively removed by the application of alcohol. Calvin B. Ross.

Springfield, O.

298. TO PREVENT THE STICKING OF HOT LEAD.

To prevent molten lead from sticking to the pot or the tools heated in it, cover the surface with a mixture of powdered charcoal, 1 quart; salt, ½ pint; yellow prussiate of potash, 1 gill; and cyanide of potassium a lump the size of a walnut.

Hardener.

299. BLACK VARNISH FOR METALS.

A good varnish for finishing metals can be made by mixing 1,000 parts of benzine, 300 parts of pulverized asphalt, and 6 parts of pure India rubber, to which is added enough lamp black to give the desired consistency to the mixture.

Bridgeport, Conn. H. A. Sherwood.

300. WATERPROOF CEMENTS.

To make a good waterproof cement in a thin paste form, dissolve 1 ounce powdered resin in 10 ounces strong ammonia and add 5 parts gelatine and 1 part solution of acid chromate of lime. For waterproof cement in paste form, add to hot starch paste one-half its weight of turpentine and a small piece of alum. T. E. O'Donnell.

Urbana, Ill.

301. TO CLEAN BRASS CASTINGS.

Brass work that has become dirty or corroded in service may be cleaned in the following wash: 1-3 part nitric acid, 2-3 part sulphuric acid, and ½ pound common salt to each 10 gallons of solution. Dip the castings in the solution for half a minute and then rinse in boiling water and dry in pine sawdust. E. W. Bowen.

Denver, Col.

302. PREPARATION FOR PRODUCING EXTREME HARDNESS IN STEEL.

The steel to be hardened should be immersed in a mixture of 4 parts of water, 2 parts of salt, and 1 part of flour. To get the steel thoroughly coated it should be slightly heated before dipping in the composition. After dipping, it is heated to a cherry red and plunged in soft water. This will make the steel harder than if simply heated and dipped in water.

S. C.

303. TO PRODUCE A GRAY COLOR ON BRASS.

First clean off with alcohol, polish the surface to an even finish, making sure that grease or finger marks are removed. Then immerse in a solution of one ounce of arsenic chloride to one pint of water until the desired color is obtained. Wash in clean, warm water, dry in boxwood sawdust, warm, lacquer with a thin pale solution of bleached shellac in methyl alcohol, using a broad camel's hair brush.

Middletown, N. Y. Donald A. Hampson.

304. NON-FLAKING WHITEWASH.

To prepare whitewash for fences, buildings, shop interiors, etc., that will not flake and fall off, mix 1 quart fine Portland cement with about 8 gallons whitewash. The cement binds the whitewash to the wood and makes a permanent covering which is unaffected by weather conditions. The small quantity of cement used and the constant stirring necessary to keep the whitewash in good condition for applying, prevents the cement hardening in lumps at the bottom of the pail, as might be expected. M. E. Canek.

305. BELT DRESSING.

The belt dressing recently recommended in Machinery—a mixture of 95 per cent of resin and 5 per cent of machine oil—is the second best compound of which I know for ruining either a rubber or a leather belt. (The first best is printers' ink.) Either of these will make a leather belt glazed and stiff, and will flake off the outer layer of any ordinary rubber ply belt. There is nothing better for leather belts than crude castor oil, applied hot. Nothing should be allowed to touch a rubber belt but hot soapsuds, or warm dilute potash or soda lye. Robert Grimshaw.

Hanover, Germany.

306. MIXING PLASTER-OF-PARIS.

Almost every one has to mix up gypsum or plaster-of-paris once in a while, but few know how to do it so as to make a smooth cream, or thin dough, without lumps. The trick is not to pour the water on the plaster, but to turn the latter gradually into the water, spreading it about in shaking it in, and to avoid stirring until all the plaster has been added. The proper quantity of gypsum is usually enough to peep out over the surface of the water over the greater part of the area; that is, about equal volumes of each ingredient. The addition of glue-water to the mixture retards setting.

Hanover, Germany. Robert Grimshaw.

307. COMPOSITION OF SPIRIT VARNISH.

The table below gives the composition in ounces of eight different kinds of varnish:

Sandarac	2	8	—	4	2	—	1	1
Best shellac	1	—	5	2	5	10	5	4
Mastic	½	—	—	1	—	2	1	1
Benzoin	—	—	—	1	—	—	1	1
Powdered glass	1	—	—	4	5	—	—	—
Venice turpentine	1	2	1	2	2	—	—	1
Elemi	½	—	—	—	1½	—	—	—
Alcohol	6	32	32	32	24	32	32	32

Varnish can be "paled" by adding 2 drachms of oxalic acid per pint of varnish; it can be colored red with dragons blood, brown with logwood or madder, and yellow with aloes or gamboge, each dissolved in spirits and strained.

Birmingham, England. W. R. Bowers.

308. IMPROVED SOLDERING ACID.

A very satisfactory soldering acid may be made by the use of the ordinary soldering acid for the base and introducing a certain proportion of chloride of tin and sal-ammoniac. This gives an acid which is far superior to the old form. To make one gallon of this soldering fluid, take three quarts of common muriatic acid and dissolve as much zinc as possible in it. This, as is well known, is the common form of acid used in soldering. Next dissolve 6 ounces of sal-ammoniac in a pint of warm water. In another pint dissolve 4 ounces of chloride of tin. The three solutions should then be mixed together. After mixing, the solution may appear cloudy, and can be cleared up by a few drops of muriatic acid, care being taken not to add too much. The acid is used in the same manner as any ordinary soldering fluid. It will be found that it will not spatter when the hot iron is applied, and also that a cheaper grade of solder may be used with it, if necessary.

Urbana, Ill. T. E. O'Donnell.

309. WATERPROOFING BLUEPRINTS.

To prevent the annoyance occasioned by having blueprints discolored by rain, drippings of mines or other similar exposures, a very simple method of waterproofing them may be effected as follows. The waterproofing medium is refined paraffine. To apply, immerse in the melted paraffine, until saturated, a number of pieces of an absorbent cloth at least a foot square. When withdrawn and allowed to drain for a few moments they are ready for use. Lay one of the saturated sheets on a smooth surface, place the dry print on top of it, and then lay a second sheet of the saturated cloth over it. Iron the top cloth with a moderately hot flat iron. The paper immediately absorbs the paraffine until saturated, becomes translucent and highly waterproofed, owing to the smooth glossy surface, which is the result of the ironing. The lines of the print will be intensified, and the paper left perfectly smooth and easy to handle. T. E. O'Donnell.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

The concluding part of the answer to the first question in How and Why, January issue, should be corrected to read as follows:

$$\text{Tan } a_1 = \frac{1/8}{12} \times \cos 45 \text{ degrees} = \frac{1/8 \times 0.707}{12} = 0.00736,$$ the tangent of the required angle or 25 minutes. The result given (25 minutes) was correct but the omission of multiplication by 0.707 made it apparently wrong.

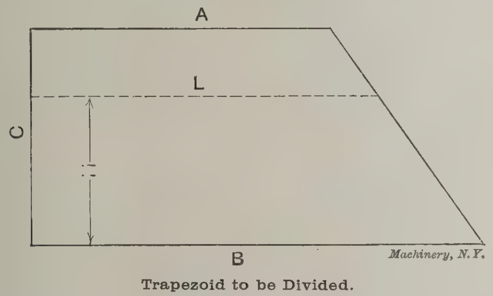
M. F. P.—What is meant by the "saturation point"? For example, some shop receipts say dissolve zinc in muriatic acid to saturation in order to make tinner's acid.

A.—A saturated solution is one that has absorbed all of a solid substance that it can carry in suspension. For example, cold water will dissolve a certain quantity of salt and when it has absorbed all that it can carry in suspension it has reached the saturation point; when the water is hot a larger quantity of salt would be dissolved so that we say the saturation point of hot water is higher than that of cold water. In making tinner's acid we simply put in a greater amount of zinc into the muriatic acid than the acid can dissolve, and thus assure the fact that we have a saturated solution; that is, one which carries all the muriate of zinc that it can hold in suspension.

Rusticus.—Will you kindly give me some rule or formula for dividing a trapezoid, by drawing lines parallel to the base, into three figures of equal area?

A.—This problem is best approached by deriving a general formula for cutting off, by drawing a line parallel with the base, an area equal to a given percentage of the whole area. Such a formula can be obtained as follows:

Let A, B and C be the dimensions shown in the diagram; let p be the decimal expressing the proportion of the whole diagram it is desired to cut off by a horizontal line parallel with the base, this percentage to be represented by the area below the line. L is the length and H the distance from the base of a line drawn to meet the given conditions. From an inspection of the figures we get the equation:



Trapezoid to be Divided.

$$\frac{H}{2}(B+L) = \frac{pC}{2}(B+A). \qquad (1)$$

This simply expresses the condition that the area below the line is p per cent of the total area of the figure, these areas being obtained by multiplying the sum of the upper and lower bases by half the altitude, according to the usual fashion. Inspecting the diagram again, we may form the second equation:

$$(B-L) : (B-A) = H : C, \qquad (2)$$

which expresses a condition so obvious that it need not be explained. Solving this second equation for L, we obtain the following:

$$L = B - \frac{H}{C}(B-A). \qquad (3)$$

Multiplying by 2 both sides of Equation 1 and inserting the value of L obtained in Equation 3, we have as a result:

$$2BH - \frac{H^2}{C}(B-A) = pC(B+A). \qquad (4)$$

This equation rearranged and solved for H gives us

$$H = \frac{C}{B-A}\left[B - \sqrt{B^2 - p(B^2 - A^2)}\right]. \qquad (5)$$

Having derived this formula, its use in the problem proposed by our correspondent is simple. If two lines are drawn parallel to the base dividing the trapezoid into three figures having equal areas, the lower line will include between itself and the base an area equal to 1/3 of the total area of the figure, while the second line will include between itself and the base an area equal to 2/3 of the whole area. Solving the formula of Equation 5 for $p=1/3$ and $p=2/3$ in turn, we get two values for H which give the heights at which the first and second lines respectively are to be drawn.

It will be understood that the trapezoid need not necessarily have one of the sides perpendicular to the base, as shown in the cut. The formula may be used for any quadrilateral having two parallel sides A and B, when C is the perpendicular distance between them.

Jeweler.—I would appreciate some information that would enable me to make laps for finishing jeweler's rolls which will remain true. My present practice of charging laps produces uneven charging and the laps soon wear out of round, thus making the rolls uneven in finish. These rolls have to be very exact and smooth, as they are used for rolling gold-filled stock which cannot be finished afterward except by buffing.

Answered by Frank E. Shailor, Great Barrington, Mass.

A.—It is impossible to charge any lap so that it will remain evenly charged if the lap is used in such a manner that will cause it to become out of round. Judging from the correspondent's inquiry, I infer that the lap is held against the roll and is not moved back and forth. This will cause it to "strip," and, of course, the lap then transfers its uneven surface to the roll. When the jeweler's rolls are ground preparatory to lapping, they are relatively speaking, quite uneven and rough; therefore, if a lap is unevenly charged and is perfectly round the high spots on the roll will soon wear minute ridges in the lap, provided that the lap is held in one position and dependence placed on the lap to true the roll. I would suggest the following method and will add that it is the best known method among fine toolmakers:

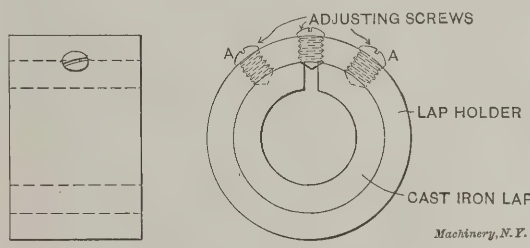


Fig. 1. Lap and Lap Holder.

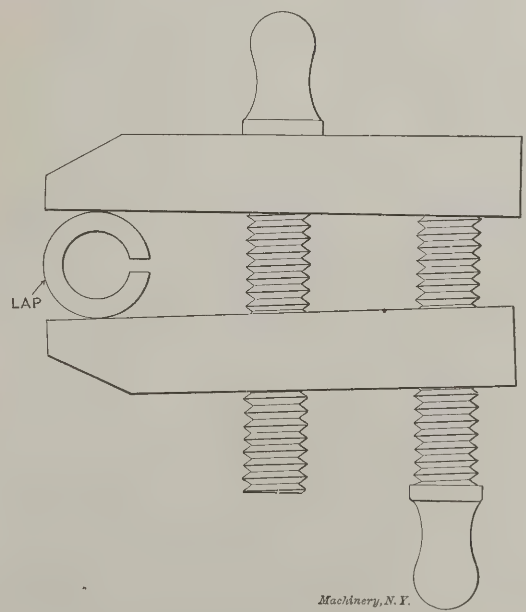


Fig. 2. Wooden Clamp used as Lap Holder.

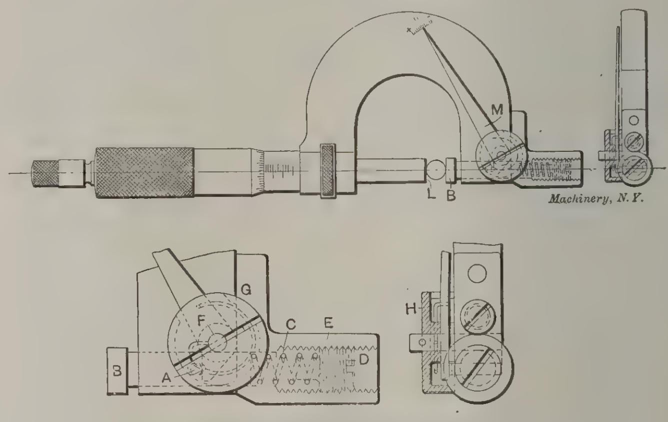
The rolls must be ground true and straight with their axes.

Particular attention must be paid to making the rolls straight before commencing to lap. The roll is gripped in a lathe chuck by its shaft and a lap of cast iron, copper or brass, such as shown in the accompanying cut, should be employed. The lap is smoothly bored or reamed to the same size as the roll to be finished, and slotted and held as in Fig. 1. The screws *A A* are provided for adjustment to compensate for wear. A wooden clamp, Fig. 2, may be employed instead of the ring lap-holder. Flour emery that has been sifted through a thick cloth bag and mixed with lard oil to a consistency of a thin paste makes an excellent abrasive for lapping. The roll is revolved and smeared with the emery paste and speeded as fast as it can run without causing the emery to fly off the roll. The lap should now be moved back and forth on the roll and kept constantly in motion, for if allowed to dwell an instant in one place it will produce ridges in the roll. The reason for this is that the emery varies slightly in size and cutting power. While it is possible to charge a lap fairly true, one cannot depend upon even cutting, therefore it is absolutely necessary that the lap be kept constantly in motion and frequently adjusted to prevent it wearing larger than the roll. The cause of a lap wearing out of round is due to lack of care in not keeping it adjusted snugly to the roll. *The lap must fit the roll snugly all the time while lapping.* Another essential point to be heeded is that the lap must be kept well moistened, especially if diamond dust is used. Diamond dust, while more expensive than emery, cuts much faster, but if the lap is run dry for an instant the small particles of diamond that are merely forced into the lap are called upon to extend more pressure than they are capable of withstanding. The consequence is that a piece of diamond will break away and back against the next particle, and so on, and in an instant the lap is "stripped." Kerosene is an excellent lubricant for diamond dust lapping. Another essential point that must be heeded is that the ends or corners of the roll will round slightly, the same being the case when lapping out a hole; the hole will become "bell muzzled." The best way to overcome this difficulty on the roll is to make the lapping ring or roll travel further than the required length, and then grind to the proper length after lapping. The width of the lap should be at least one-third the length of the piece to be lapped. Rolls that have become rust eaten must be ground true before they can be lapped, for the abrasive will lodge in the rust spots and will quickly cut ridges in the lap. Rolls that have become hollow from long usage can be trued with a lap, but it requires much skill both in handling the lap and in the use of micrometers, by which the straightness of the roll is determined. The point to be fully understood is that for very accurate work one can never depend on the truth of a lap, for no matter how evenly charged it is, it will have keener cutting points in one place than another, hence the necessity of keeping it constantly in motion so as to distribute the cutting action evenly over the whole surface of the roll.

* * *

SENSITIVE MICROMETER ATTACHMENT.

When testing the diameters of pieces that are handled in great quantities and are all supposed to be within certain close limits of a standard dimension, the ordinary micrometer presents the difficulty of having to be moved for each piece, and small variations in diameters have to be carefully read off from the graduations on the barrel. Not only does this take a comparatively long time but it also easily happens that the differences from the standard diameter are not carefully noted and pieces are liable to pass inspection that would not pass if a convenient arrangement for reading off the differences were at hand. The accompanying cut shows a regular Brown & Sharpe micrometer fitted with a sensitive arrangement for testing and inspecting the diameters of pieces which must be within certain close limits of variation. The addition to the ordinary micrometer is all at the anvil end of the instrument. The anvil itself is loose and consists of a plunger *B*, held in place by a small pin *A*. The pin has freedom to move in a slot in the micrometer body, as shown in the enlarged view in the cut. A spring *C* holds the plunger *B* up against the work to be measured and a screw *D* is provided for obtaining the proper tension in the spring. The screw and the spring are contained in an extension *E* screwed and dowelled to the body of the micrometer. A pointer or indicator is provided which is pivoted at *F* and has one extensional arm resting against the pin *A*, which is pointed in order to secure a line contact. At the end of the indicator a small scale is graduated with the zero mark in the center, and as the indicator swings to one side or the other the variations in the size of the piece measured are easily determined. A small spring *G* is provided for holding the pointer up against the pin *A*. The case *H* simply serves the purpose of protecting the spring mentioned. As the plunger *B* takes up more space than the regular anvil the readings of the micrometer cannot be direct. The plunger *B* can be made of such dimensions, however, that 0.100 inch deducted from the barrel and thimble reading will give the actual dimension. Such a deduction is easily done in all cases. In



Sensitive Micrometer Attachment.

other words, the reading of the micrometer should be 0.100 when the face of the measuring screw is in contact with the face of the plunger; the 0.100 inch mark is thus the zero of this measuring tool.

When wanting to measure a number of pieces, a standard size piece or gage is placed between the plunger *B* and the face *L* of the micrometer screw and the instrument is adjusted until the indicator points eactly to zero on the small scale provided on the body of the micrometer. After this the micrometer is locked and the pieces to be measured are pushed one after another between the face *L* and the plunger *B*, the indications of the pointer *M* being meanwhile observed. Whenever the pointer shows too great a difference the piece of course does not pass inspection. All deviations are easily detected, and any person of ordinary common sense can be employed for inspecting the work.

* * *

One of the very necessary little things in the make-up of a publication is the "filler." What is a filler? Simply an idea or bit of information expressed in a number of lines that just happens to fill the yawning gap between the end of some article and the foot of the page. In fact probably this will be used as one. The make-up editor treasures his fillers, arranging and re-arranging the make-up—whisper it softly—to suit the fillers, oftentimes. In time of stress he is sometimes known to use the shears on a contemporary and lift bodily some item that happens to fill an aching void. Who can blame him if, in his hurry, he sometimes forgets to acknowledge the source of his salvation? But it is nevertheless amusing and sometimes the least bit irritating to see an item, on which we have spent our valuable time "writing and rewriting, polishing and repolishing," going the rounds of the press, a lone orphan, the sport of fortune and anything else pitiable that the reader can think of. But to get down to what we started out to say: In the October, 1905, issue a note was published in MACHINERY on the relative strength of grindstones when wet and dry, being an abstract of a report published on investigations made in the Sheffield district, England. The item has since floated around through many of the trade papers, and the last seen of it was in the *Journal of the Franklin Institute*, credited to the *Iron Age!* So, at last, this poor lone note has found place and position—embalmed as it were with the odor of respectability. It is well!

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

A GEAR-DRIVEN UNIVERSAL MILLER.

In the December, 1905, issue of MACHINERY we illustrated and described a gear-driven Milwaukee plain milling machine. The builders of this machine, the Kearney & Trecker Co., Milwaukee, Wis., have now re-designed their universal machines along the same lines, and they propose to give up the building of the cone-driven style entirely, having evidently the courage of their convictions as to the superiority of the single pulley and gear-driven type. Besides this matter of drive, and the general stiffness and weight of the machine,

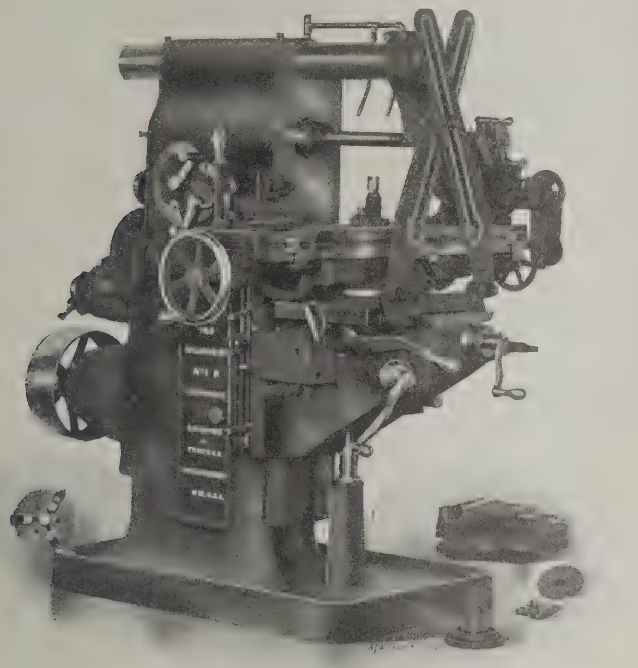


Fig. 1. Milwaukee Gear-driven Universal Milling Machine.

there are other details of design which show that the builders believe there is a demand for a machine fitted with the best of conveniences for effective service, even when these conveniences add considerably to the expense of building the machine. For instance, elaborate provision is made for lubricating the gears and journals of the spindle driving and feed mechanism. Near the base of the machine in Fig. 2 will be seen a funnel and a drain cup leading to a reservoir for lubricating oil. A circulating pump connected to the driving shaft, and running even when the spindle is motionless, carries the oil from this reservoir to every point where it is needed for the mechanism within the column. The oil used in this way returns by gravity to the reservoir, and is again pumped back. From time to time a sample of the oil may be drawn off through the valve, and its condition noted. If it is dark with considerable dirt and mineral in suspension, it should be filtered, after which it is again ready for use. Besides this provision for circulating the lubricating oil, a second reservoir is provided for cutting oil. A tank for this is reached through the door in the side of the column shown in Fig. 1. A second pump takes the liquid from this tank, forces it through the pipes and flexible tubing over the spindle onto the revolving cutters. A carefully arranged series of screens, drains, and cored passages leads the oil from the table through telescopic tubing from the saddle to the base of the column, as shown in Fig. 2, and back to the reservoir again. This pump is not an attachment furnished at an extra cost, but is invariably included in the equipment. A universal miller, engaged in the work for which it is best suited, is working on machine or tool steel the greater part of the time, and on this work a good lubricant should always be used. The arrangements provided are fitted to use this lubricant in the most effective way. The makers advise that the best grade of lard oil be employed, as this, in the long run, has proven to be the cheapest and most satisfactory.

Aside from the universal features of the machine, the general design is similar to that of the plain miller previously described. In Fig. 1 a vertical lever may be seen, pivoted in the column and showing just back of the tailstock spindle on the work table. This lever is used for starting and stopping the machine independently of a countershaft. As usually arranged, the driving pulley is belted directly from the line-shaft. This makes it possible to get a new machine into operation very quickly, and does away with the troublesome features of friction pulleys and elaborate overhead works. When a motor drive is wanted, it is substituted in place of the pulley bracket, and the resulting combination has a very pleasing and harmonious appearance. The 18 speed changes are obtained entirely by gearing. The two cranks seen at the side of the column, back of the starting and stopping lever, provide for this. The upper one has three positions, and the lower one has six. This combination gives the 18 spindle speeds, with a range of from 15 to 354 revolutions per minute in increments of 20 per cent. While it is entirely possible to change the speed with the machine running, it is not considered feasible or necessary, as the frequency with which changes of speed are required in milling machines is much less than in lathes, for instance, used in turning different diameters. A miller set up for a job uses the same sized cutter, which is not changed until the machine is set up for another job; besides the starting lever is easy to reach at any time when it may be desired to stop the machine. An index plate is provided showing the speeds obtainable. A hand wheel at the rear of the column just under the spindle

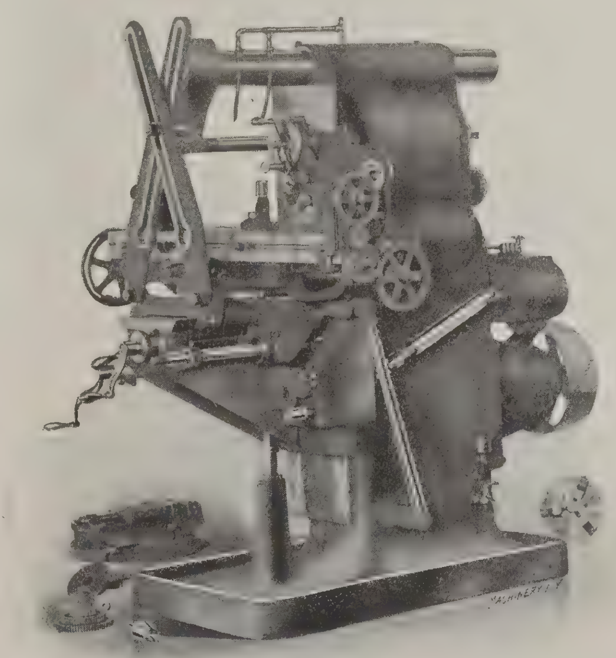


Fig. 2. Right-hand Side of Universal Miller, showing Oiling Arrangement and Spiral Head.

is partially shown in both cuts. This is used to turn the spindle by hand through small angular movements when this is necessary. The spindle is provided with a hardened collar for driving the cutter arbor, and with a draw-in bar to hold the arbor in place and force it out again.

The feed change levers, which may be seen at the rear of the machine in Fig. 2, operate a mechanism similar to that used in changing the spindle speeds. Ten changes are available, giving feeds of from 0.55 to 16.0 inch per minute, the feed per minute in all cases being independent of the spindle speed. In combination with the changes of spindle speed on this size machine, from 0.001 to 1.066 inch feed per revolution of spindle is obtainable. Automatic vertical and longitudinal feeds are regularly supplied on all the machines whether ordered or not, and positive automatic stops are provided at the limits of

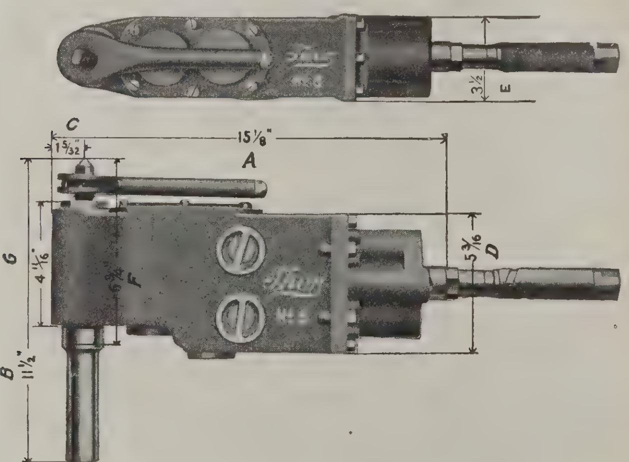
the movement of all feeds to prevent accident. Adjustable stops are also supplied to trip the feed at any point desired. The fixed stops are immovable so that the operator cannot accidentally hit them. The arrangement of the feed controlling levers makes it impossible to engage two feeds at the same time.

The table is made to swivel in the manner common to all universal milling machines, but modified in such a way as not to interfere with the return of the lard oil or other lubricant from the table to the reservoir in the closet of the machine. Ball bearings are provided to take the thrust of cross table and elevating screws. The three-jaw universal milling machine chuck used with the spiral head has reversible jaws. This is a departure from the usual practice, but it is thought to be justified, as the old fashioned milling machine chuck only permits the holding of work of comparatively small diameters, whereas it is often convenient to hold pieces of widely varying character in the chuck. Many of the features found useful in the cone pulley millers have been incorporated in the design of the new machines. For example, the extended knee slide of the column was carried above the spindle bearing primarily to furnish a convenient place for clamping the vertical spindle and other attachments, and incidentally to add to the stiffness of the spindle bearing. This last advantage is not so apparent in the new machines, as it will be seen that the box form of frame, without an opening for the cone pulley, leaves nothing further to be desired in the matter of stiffness of the column itself.

The cuts show the No. 1 B, the smallest of three sizes, all of which are uniform in design.

A PNEUMATIC DRILL FOR CLOSE QUARTERS.

The Independent Pneumatic Tool Co., of Chicago and New York, have recently perfected a machine designed as their "Thor" No. 8 close quarter piston air drill which, as may be seen in the accompanying cuts, is especially suited for drilling in close quarters and in corners where the ordinary drill can not be used. The device is capable of drilling holes up to 2½ inches in diameter in any ordinary metal. It has no delicate



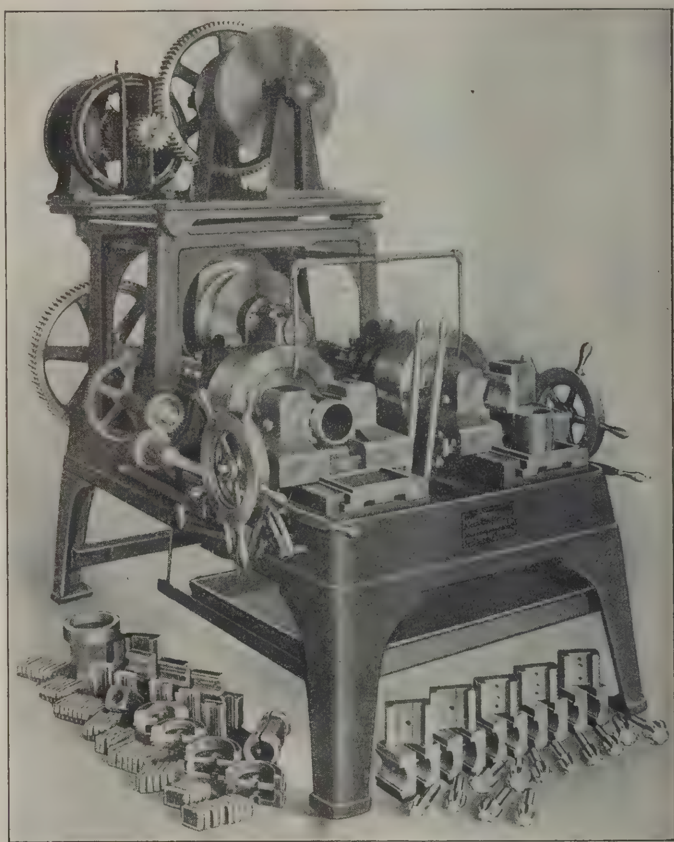
Pneumatic Drill for Close Quarters.

mechanism and is very easily handled and operated. The principal dimensions are shown on the cut, and its compactness will at once be appreciated. The makers state that they will send this drill on approval to any one desiring to make a test of it.

THE MURCHEY DOUBLE-HEAD NIPPLE AND PIPE THREADING MACHINE.

The Murchey Machine & Tool Co., corner 4th and Porter Streets, Detroit, Mich., in the design of their double head pipe threading machine, have provided sufficient power to thread two 4-inch pipes simultaneously. The cut shows a motor-driven machine, but it can be arranged to be belt-driven if desired. The die heads of the machine have steel bodies and are of an entirely new design. There are six chasers in each, rigidly held in radial slots by a face ring. The head is in two parts and opens automatically, by the action of the reamer coming in contact with the end of the pipe when the thread has reached its proper length. The processes of reaming and threading are performed in this machine at the same operation, and by making the opening of the dies depend on the contact of the reamer with the work, perfectly reamed pipes and uniform lengths of threads can be obtained regardless of the position of the pipe in the vise. There is a separate reamer furnished for every size pipe within the range of the machine. The unusual bearing surfaces of the vise jaws adapt the machine especially to the threading of very short nipples.

Another important improvement is the lead screw attachment furnished as part of the machine. With this arrangement, instead of starting the cut by hand, the operator simply clasps the pipe in the vise jaws and throws in the lead screw, no further attention being required. The same thing is done



Murchey Double-head Nipple and Pipe Threading Machine.

for the other head of the machine. The first thread has meanwhile reached its proper length, the end has been reamed, the dies have opened automatically, and the lead screw has been released. The mechanism, for effecting the simultaneous release of the lead screw and opening of the die head is extremely simple, though positive and effective, no special care being required in adjusting it. Great care has been taken to make every detail of the machine as nearly fool-proof as possible.

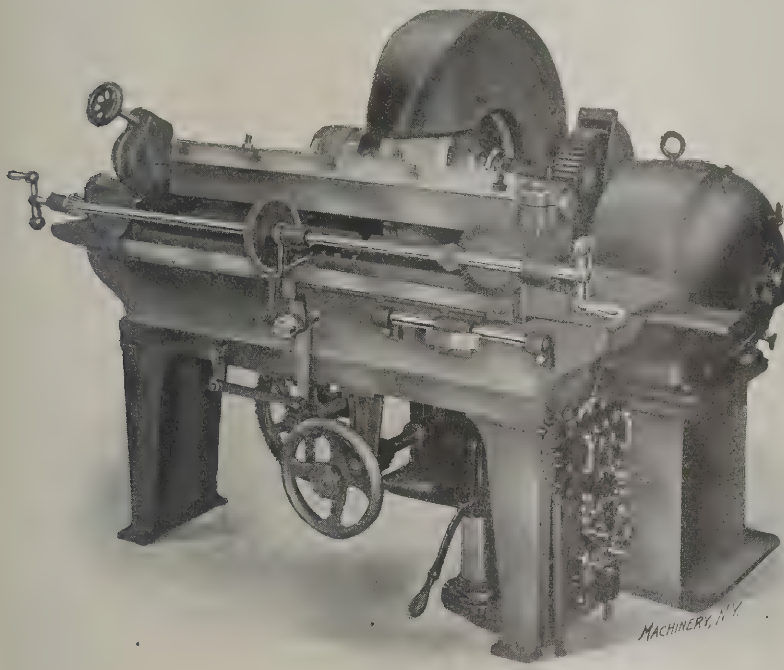
The cone pulley has three steps with diameters from 12 to 16 inches for a 3½-inch belt. With one change by gearing, this gives six different speeds; with the back gears thrown in for heavy work the gear ratio is 25 to 1. The motor shown attached to the machine is of 3½ horsepower and is furnished by the Triumph Electric Co. of Cincinnati. The makers of this machine claim that it will easily produce 700 four-inch threads in ten hours.

THE BRIDGEPORT MOTOR-DRIVEN KNIFE GRINDER.

Among the improvements introduced by the Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn., in the knife grinder shown herewith, are, the use of a motor-driven wheel, an improved method of knife support and feed works, and carefully arranged provisions for supplying the wheel with water and returning it to the tank after use.

The knife which is being ground is clamped to a hollow, square knife bar or support of great strength and stiffness. The bolts which hold the knife to this bar pass entirely

through it, and so are easily inserted and removed. This work support is pivoted at the ends to the two sliding bearings, thus furnishing a means for grinding the edge to any angle desired, the adjustment for this being obtained by a worm and wheel arrangement operated by the hand wheel shown at the left of the work table. A graduated index shows the angle obtained. The sliding bearings in which the work



A Motor-driven Knife Grinder.

support is pivoted are moved forward simultaneously by feed screws geared to move together, under the influence of the longitudinal shaft shown at the front of the table. Provision is made for clamping the work in approximately the correct position, and adjusting it afterward so that the wheel will grind the same amount from each end. This is done by slipping one of the bevel gears on the horizontal feed shaft out of mesh with its mating gear, when one bearing may be adjusted out and in by the feed crank while the other remains stationary.

An automatic traverse is given to the table, its motion being determined by the adjustable dogs shown, which act in the same way that the stops on a planer table do. The work is fed in automatically at the end of a stroke by the action of a double wedge, adjustably mounted on the round bar support shown at the right hand end of the bed. This acts on a swinging lever pivoted by the feed shaft, operating a ratchet wheel attached to it. The feed thus obtained may be adjusted to give the work as fine an advance as 0.001 inch for each traverse of the carriage. The carriage drive is strongly back geared and all the gears are cut from the solid. The carriage runs on a wide flat track with the outer edges gibbed under the bed to hold it securely in alignment, and is provided with side adjustment for wear in that direction. It is thus impossible to force the carriage off the ways if the wheel is forced against the work. The carriage is so constructed as to cover the sliding surface of the bed while in action.

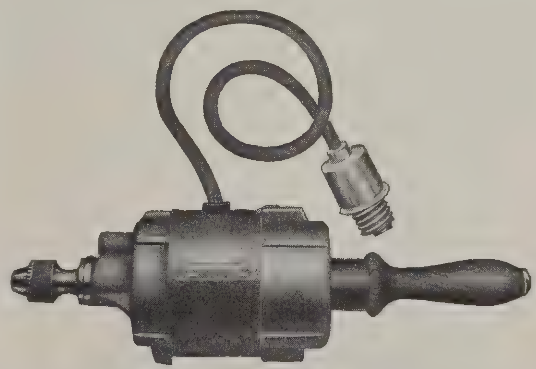
The emery wheel is set on a back extension of the bed of the machine in a mounting so arranged that when the wheel is partially worn out it may be set forward to use the remainder. This extension on which the wheel is mounted is utilized also for a water compartment. A patented air pump mechanism forces the water from the lower tank into the upper compartment under the wheel. Suitable guards and pans catch the drip from the knife bar and carriage, and conduct it back to the reservoir. This use of water prevents the glazing and heating of any portion, and obviates the danger to the wearing surfaces of the machine from emery dust flying about loosely in the air. This tool, known as the improved medium weight knife grinder, is made in four sizes for traverse of 32, 42, 52, and 62 inches, either belt- or motor-driven. The emery wheel shown is 26 inches in diameter by 1½ inch wide.

THE FEDERAL BLUEPRINTING MACHINE.

The Keuffel & Esser Co., 127 Fulton Street, New York, announce their purchase of the patent rights to the Federal blueprinting machine. Among the points of superiority claimed for this device over other machines of the same kind are: The effective use of the intense light furnished, thus making continuous printing possible at nearly as high rate of speed as possible with the most favorable sunlight; the continuous action which obviates loss of time in preparing the apparatus for each separate exposure; the absence of glass or other fragile material in the machine; and the extreme ease of manipulation, no handling of heavy parts being required. The device consists essentially of a large drum mounted in roller bearings, an apron of transparent material for getting smooth contact between the drawing and the blueprinting paper, a reflector containing electric lamps, a small electric motor, a speed controlling device, and an arrangement for regulating the tension upon the apron. The fact that the work is fed and discharged on the same side of the machine saves a great deal of time, and a further advantage is that the operator is able at all times to examine the prints coming from the exposing chamber and to vary the speed of travel as may be required. The device is made in three sizes for prints up to 30, 42, or 54 inches wide, and is equipped with respectively 4, 6, or 8 lamps. The height of the machine from the floor to the top of the lamps is 4 feet 10 inches. Its depth is 4 feet 6 inches, and the width of the three sizes is respectively 4, 6, and 10 feet.

A DIMINUTIVE ELECTRIC DRILL..

The tool shown below, manufactured by the United States Electrical Tool Co., of Cincinnati, Ohio, is exceedingly compact and light considering the work it has to do. The prime necessity in the construction of portable electric tools of all kinds is to reduce the weight as much as possible, at the same time keeping the power sufficient for the rated capacity, or in other words, the tool must not be over-rated. The tool shown is a 3/16-inch drill weighing 6 pounds. It is capable of drilling



A Small Drill, built by the United States Electrical Tool Co.

holes of up to the size mentioned in wood, iron or steel and the motor will easily develop ¼ horsepower. It is especially suited for such work as drilling holes for oil, nameplate screws, etc., in the machine shop. Extra handles of various patterns are supplied when necessary, making the tool a useful one for many different operations.

A HEAVY TOLEDO STAMPING PRESS.

The modern tendency toward increase in the range of work required of stamping presses, and other machinery of the same type, is well illustrated by the line cuts of the work shown in Fig. 2, and the halftone of the massive machine used in producing them, as shown in Fig. 1. While with hydraulic presses and red hot stock to work on, the operations indicated would be common everyday affairs, when it comes to

the question of performing them on cold stock in belt-driven machines, the task is one of unusual magnitude. The builders, the Toledo Machine & Tool Co., Toledo, Ohio, believe this press to be the largest and most powerful one of the kind in operation in this country.

The first stamping, of ¼-inch steel plate, is made from a 20-inch blank. This piece is formed and the center opening cut out and flanged in two operations. The second sample is made of plate ½ inch thick. The center opening was cut and

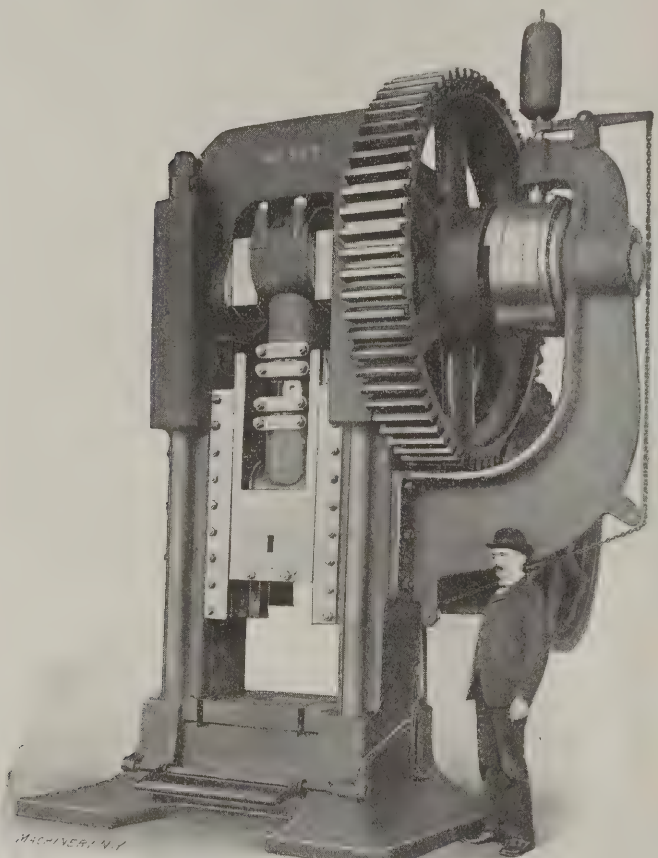


Fig. 1. Stamping Press of Unusual Size.

flanged in three operations, the flange being about 2 inches high. This work was performed on the special press shown, designed and built for the Crosby Company of Buffalo, who make a specialty of producing stampings of this character for a wide range of work.

Some idea of the size of the machine may be obtained from the following measurements. The frame, which is of cast iron and made in one piece, weighs 42,800 pounds and has a capacity of resisting a pressure of 1,200 tons. The distance

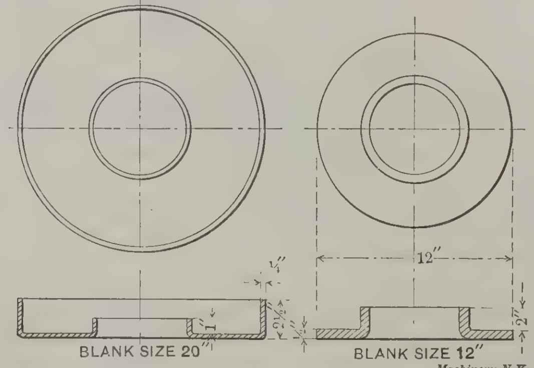


Fig. 2. Samples of Work, Stamped Cold in the Machine shown above.

from the bed to the slide, with stroke and adjustment up, is 31 inches. The diameter of the crankshaft at the crank bearing is 13 inches, and the stroke is 14 inches. The gearing is in the ratio of 40 to 1, and the main gear is 14 inches face by 92 inches in diameter, and weighs 9,000 pounds. The 60-inch flywheel weighs 2,400 pounds. The total height of the machine to the top of the large gear is 14 feet 8 inches, and the total weight is 100,000 pounds.

CHASING ATTACHMENT FOR THE FLAT TURRET LATHE.

In determining what work should be done in the engine lathe and what in the turret lathe, there has always been one field in which the older machine has still kept the advantage. When short threads of large diameters are called for, where accuracy, both of size and alignment, is required, the necessary operations are performed on the engine lathe, with the usual change gear and lead screw apparatus. Various devices have been tried on the screw machine to compete with this process. The lead screw has been applied, as on the engine lathe, and the Fox chasing attachment has also been used to good advantage in many classes of work. The engine lathe scheme, however, employs a long screw which wears in one spot in the average run of work, and there are besides many joints, both sliding and rotary, between the spindle and the tool, and the lost motion in these joints results in a large thread at both ends of the screw. The Fox chasing apparatus is much more simple and effective in its operation for this work, and is much quicker in action as well, although its use is restricted to short threads. The weakness of the device, however, has confined its use almost wholly to the softer metals. The Jones & Lamson Machine Co., of Springfield, Vt., who make the attachment we are about to describe, applied the Fox chaser in the '80's and later in the 90's to their machines, but do not consider the arrangement stiff enough to control the tool properly.

The device illustrated in Figs. 1 to 4 is designed to obviate the difficulties of both the older arrangements. It may be

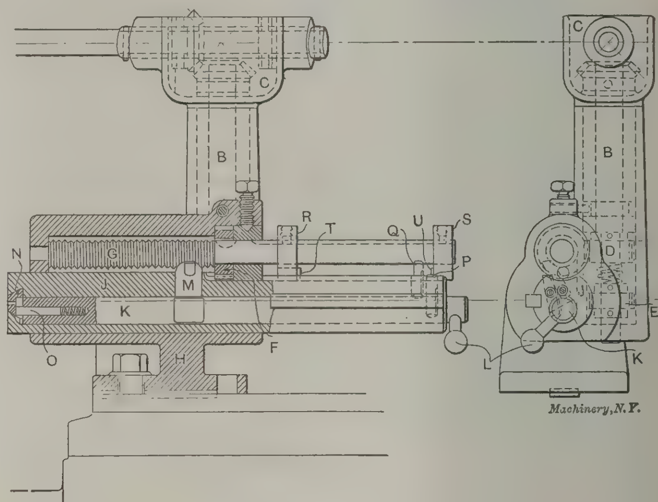


Fig. 1. Construction of the Mechanism of Chasing Attachment.

readily applied to any form of lathe, although at the present writing it is the intention of the builders to restrict its use to the Hartness flat turret lathe. Referring to the halftone, Fig. 2, and the line cut, Fig. 1, it will be seen that a horizontal shaft, A, connected by the spiral gearing shown to the spindle of the machine, drives the vertical shaft B of the device through the bevel gearing in case C. This vertical shaft carries a spiral gear at D and a spur gear at E. The spur gear is driven by the frictional pressure of two collars, maintained by the spring indicated by the dotted lines. The spiral gear D drives a mating gear F, keyed to the lead screw G, which thus revolves constantly in one direction. This lead screw is mounted in a holder H fastened to the flat turret; within this holder is the tool bar J which is keyed to prevent turning, but is free to move forward and back. The tool bar carries throughout its length a rod K which may be rocked by handle L. In the position shown for this handle, plug M, which serves as a nut for the lead screw, is raised into contact with it; and the tool N, which is dove-tailed to the face of the bar J, is moved forward into cutting position. If now handle L is raised, a flat on shaft K allows nut M to drop out of engagement with the lead screw; eccentric pin O, engaging a slot in tool N, withdraws it from the work, and the friction driven gear E, meshing with rack teeth on the further side of tool bar J, causes it to be rapidly withdrawn.

The alternate raising and lowering of handle L, required for the operation of the attachment, may be performed automatically by the device itself. Two plugs, P and Q, are pro-

vided; if P is depressed, handle L will be lowered, while if Q is depressed, handle L will be raised again. Stop collars R and S, on an extension of the lead screw, limit the travel of the tool and the length of the thread which may be cut. With the parts in the position shown, with the tool

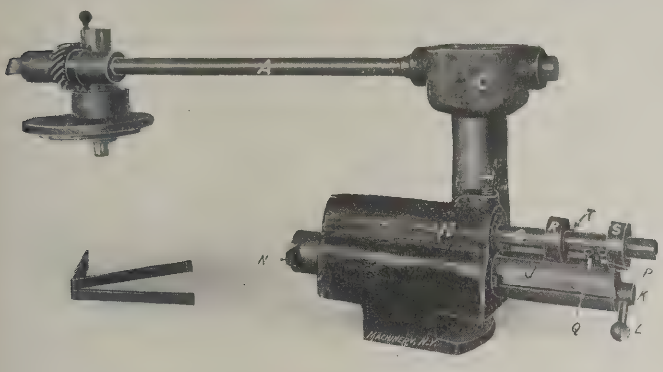


Fig. 2. Chasing Attachment for the Flat Turret Lathe.

advancing slowly forward on the cutting stroke under the action of lead screw G and nut M, the action continues until tappet Q approaches revolving collar R, when pin T, mounted in this collar strikes the top of Q, knocking it down, raising handle L and thus withdrawing tool N from the work, and nut M from engagement with the screw, by mechanism previously described. Friction-driven gear E is then able to withdraw the tool bar J, which action persists until tappet P strikes stop collar S, thus limiting the backward movement. Here the bar remains for a fraction of an instant until pin U in this collar strikes the top of tappet P, lowering handle L, moving the tool outward and throwing nut M into engagement with screw G, whereupon the cutting action again commences.

It will thus be seen that the cutting edge is advanced at the proper rate of speed for threading, withdrawn after the proper length of stroke has been taken, returned to its first position, again advanced to cutting depth, fed forward, and so on without attention on the part of the operator as long as the device is in use. The successive increases in depth of cut for each chip are made by advancing the cross

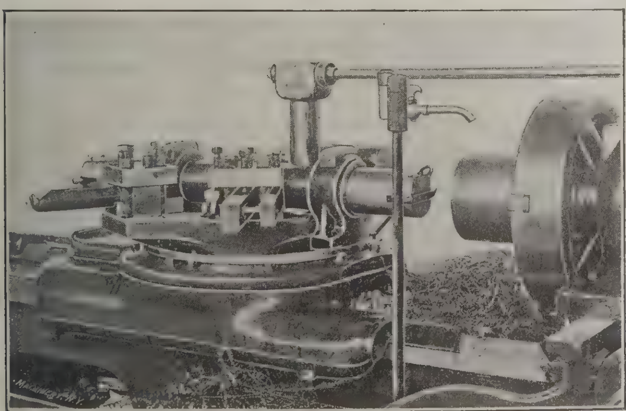


Fig. 3. The Attachment in Position for Operation in Connection with a Boring Bar.

sliding head of the machine the amount required each time. In changing from one pitch to another, it is only necessary to replace screw G and nut M, an operation as easy as the changing of gears on a lathe. For cutting left hand threads, bracket C is reversed so as to drive spindle B in the opposite direction with relation to the spindle of the machine. Though either a single-threaded tool or one of chaser form such as shown in Fig. 2 may be used, in the latter case sufficient clearance must be provided to the side cutting edges to allow the lead screw to guide the tool without interference from the action of the work on the chaser. It will be noted that the constantly exerted pressure of friction gear E takes up all backlash in the mechanism itself, and that the turret slide is stationary throughout the operation, and may be even clamped to the bed. These two conditions are very favorable ones for the production of accurate threads.

Fig. 4 shows the apparatus mounted on the turret, and Fig. 3 shows it in action, although it is more or less obscured by the heavy boring tool mounted opposite it at the same station of the turret. When seen in operation as set up in this way, however, its movements are very interesting, the mechanism involved in its construction seeming ridiculously simple when compared with its complicated functions.

Fig. 4 incidentally gives a view of the swivel chuck jaws furnished with the flat turret lathe the action of which is very simple. It is well known that a four-jaw chuck generally tends to flatten slender work one way more than another, but even if it were possible to get an even pinch on each pair of jaws, there still remains the fact that there would be a tendency to squeeze the piece to a four-sided form. A three-jaw chuck gives equal distribution of pressure to each edge, but it has a still greater tendency to deform the work. By the use of the swivel jaws the equal pressure of the three-jaw construction is retained, but by dividing this pressure into six different points of application, the use of great holding power is permitted without appreciably distorting the work from its natural form.

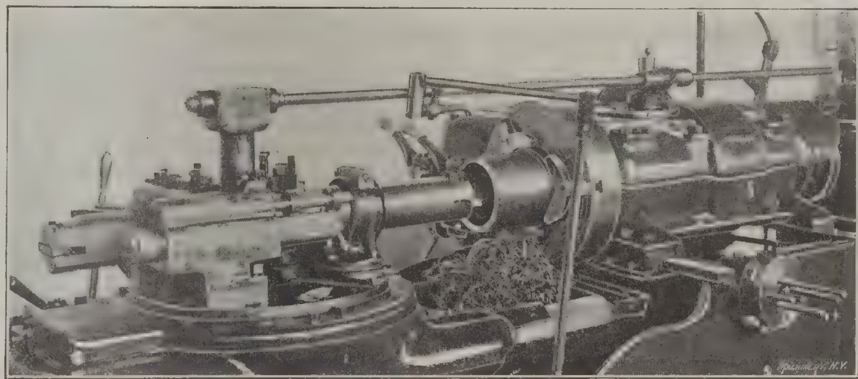


Fig. 4. The Attachment in Place on the Flat Turret.

The turret chasing tool just described is not part of the regular equipment of the flat turret lathe, but it may be added to any machine recently shipped. It cuts screws of any diameter from the 12 or 14 inch swing of the lathe, down to 2¼ inches in diameter for internal threads, and about 1 inch for external threads, of any length less than 5 inches. The holder may be swivelled for cutting taper threads, or may even be employed for taper turning to very good advantage.

A UNIVERSAL TOOL-MAKER'S VISE.

The Patterson Tool & Supply Co., of Dayton, Ohio, have lately undertaken the sale of the swivel vise shown in Figs. 1 and 2. It should prove to be a very handy device for toolmakers and machinists, since it may be used for a variety of

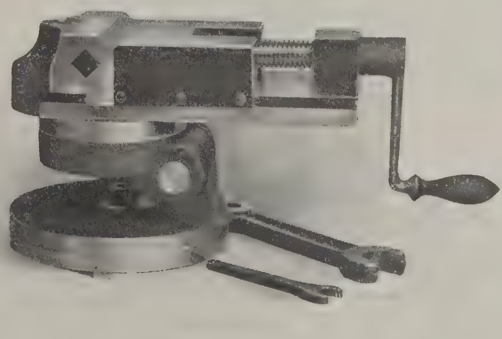


Fig. 1. Universal Vise in Horizontal Position.

operations that would otherwise be quite difficult. As may be seen, it consists of a base which is clamped to the table of the machine, an intermediate plate which can be clamped to the base at any angle in a horizontal plane, and a bracket ad-

justable in a vertical plane about a pivot attached to the intermediate plate; this bracket carries, in turn, a vise of simple construction. It is thus possible to present a piece of work to a cutting tool in the drill press, shaper, miller, or other machine, at any desired angle with relation to the rectangular surface by which it is held. The width of the jaw is 4 inches. The total height when in a horizontal position is 6 inches. The extreme capacity when the jaws are open is 3⅛ inches; the diameter of the base is 6 inches and the weight is about 28 pounds.

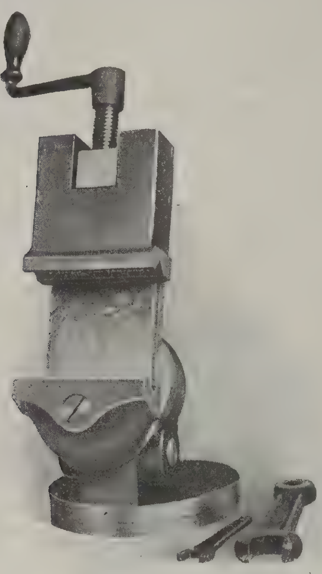
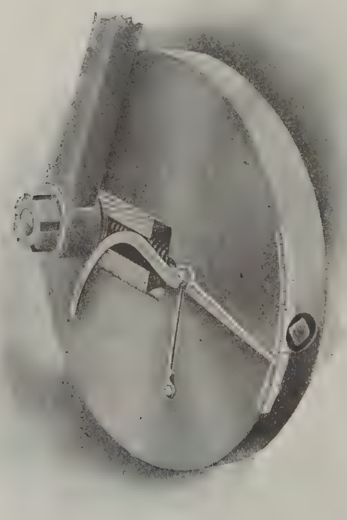


Fig. 2. Vise Set for Angular Cut.

A STROKE INDICATOR FOR THE SLOTTING MACHINE.

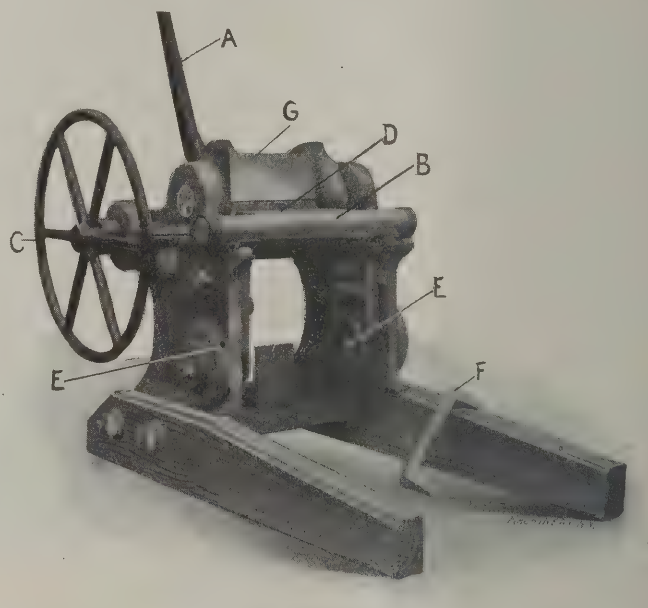
The T. C. Dill Machine Co., Philadelphia, Pa., have devised a stroke indicator for their slotters, which serves the same purpose as the graduated dials usually furnished with shapers for indicating the length of travel of the ram. As may be seen from the cut shown herewith, the device is extremely simple, consisting only of a pointer having a curved inner extension bearing against the adjustable crankpin of the crankshaft. The spring provided keeps it pressed against the pin as it is adjusted out and in. The shape of the curved portion of the lever is such that the outer end, or pointer, traveling on the scale shown, will indicate the length of the stroke on evenly spaced graduations. It is believed by the builders that this device will be appreciated by anyone familiar with the difficulty of setting a slotter by guess to the proper stroke. By the usual method of adjusting the machine, if the first guess is not right a second is made, and so on. The last guess may not be right but the time lost in changing to a more accurate setting would be almost as great, (so the operator imagines) as the time to be gained by changing the stroke, not to mention the extra exertion required; so the machine continues to go with perhaps a couple of inches more travel than is needed; whereas had the stroke been right, the machine might perhaps have been run at a faster rate, making more strokes per minute at the same cutting speed.



The Dill Slotter Stroke Indicator.

THE PENNOCK IRON BENDING MACHINE.

The American Road Machine Co., Kennett Square, Pa., have been building for some years an iron bending machine which has found extensive use in car shops, iron works, etc. Since it has only recently been introduced as a machine shop tool, a description of it may be interesting to our readers. There are two dies on the machine, the lower one of which is marked *B*. This is moved in a horizontal direction by means of hand wheel *C*. The material to be bent is inserted between the two jaws at *D* and by means of the hand wheel, the dies are made to clamp the material so that it is held in the position desired for bending. To accommodate varying thicknesses of stock the lower jaw can be moved in a vertical direction by means of eccentrics *E E* as shown. After the material has been clamped in place, lever *A* is moved downward, thus bringing the upper die marked *G* in contact with the material to be bent, drawing it down to the lower die, or, in case a different angle from that of the die is desired, bringing it down to a die block such as is shown at *F* in the cut. It will be seen that this is a very simple operation, though a surprising variety of irregular shapes may be produced. Its extreme capacity for thickness of stock is 1½ inch. It will take a sheet of any width to 12 inches. Small iron is worked cold, while the heavier sections are heated.



The Pennock Iron Bending Machine.

* * *

The dream of the electrical engineer has been to burn coal at the mine's mouth and transmit the generated power by electricity to the users in towns and cities. The cost of long transmission lines and loss of efficiency have prevented such projects being carried out; practically all the longest transmission lines in existence are those operated by water power. It appears, however, that the dream of the electrical engineer is about to be realized. An electrical corporation has been chartered at Hazleton, Pa., for the purpose of manufacturing electricity and furnishing it for the purpose of light, heat and power to the counties of Luzerne, Columbia, Schuylkill, Berks, Lehigh, and Northumberland. A big power plant is to be erected at Harwood and the lines of wires will reach to Reading, Allentown, Sunbury, Mauch Chunk, Shamokin, Bloomsburg, and various towns and hamlets within a radius of 100 miles or so. The scheme is to burn the vast piles of culm and rice coal that have accumulated during the last fifty years. The rice coal is a very low grade of fuel, containing a large percentage of slate, and is profitable to use only where it can be burned without rail transportation. It is possible that this scheme is only the beginning of a much larger scheme which will ultimately transmit power to the larger cities like Philadelphia, New York, Baltimore, and others within a few hundred miles of the hard coal regions.

EUROPEAN INDUSTRIAL NOTES.

TENDENCIES IN BRITISH MACHINE TOOL DESIGN.

The year 1906 has been one of almost unexampled activity in the British engineering trades, and probably no branch has been more heavily engaged than that devoted to the manufacture of machine tools. Several advances in wages have to be recorded, but one of the most serious disputes—the strike for a wage advance of iron shipbuilders and boilermakers on the Clyde—ended in the return of the strikers to work without any concession being obtained. The strike was not well timed, the "boom" in shipbuilding having then declined for the time being, and consequently the employers were comparatively little inconvenienced. As previously mentioned, specialization in tool building is becoming decidedly more marked than in the past, though the tendency is still characteristically modified by due regard of caution.

A number of makers are specializing on high-speed, or perhaps more correctly, high-power, lathes, while many others build such tools to order or in smaller lots than the first-named. Langs, of Johnstone, Scotland, have gone about the most largely into mass production of lathes which, in addition to high power, embody very complete arrangements for automatically varying the cutting speed in accordance with the diameter of the work being dealt with. Others, by special design of headstock and fine gradation of speeds, bring the cone drive about up to its limit of efficiency. Constant-speed belt and "all-gear" drive forms the special feature in the leading lines of other builders. In many cases more or less well-founded claims are made on account of improved design of the beds and tailstocks, as also quick change arrangements of feeds and devices for preventing sliding and screw-cutting feeds being engaged simultaneously. Motor-driven headstocks are becoming more often on offer, and the stiff proportions of tailstocks, their correct alignment and secure clamping are points on which special stress is laid by several concerns, one of which uses ratchet teeth on the under side of the shears into which corresponding teeth on the clamp plates engage. Taken altogether, the tool builders would appear to have easily overhauled the tool steel makers' products, so the next move will lie with the steel makers.

High-speed planing, of course, presents its own problems, which are being tackled with decidedly encouraging results by toolmakers generally, and by a few specialists devoting themselves solely or principally to their commercially successful solution. The Bateman's Machine Tool Co., Ltd., Leeds, specialize on the light and moderately heavy classes of machines adapted for quick cutting with depths and widths of cuts likely to be required by general users. The racks under the tables, controlled by suitable springs, have—before acting integrally with the table—sufficient longitudinal motion to absorb the momentum of the moving table and work, and, within fine limits, reverse, without shock. (For description with cut see MACHINERY, July, 1905.) From the latest data issued by the company, the following may be taken as typical performances on regular machines:

	Forward Stroke.	Return Stroke.	
24 in. x 24 in. x 6 ft....	78 ft.	210 ft.	
36 in. x 36 in. x 20 ft....	23 ft.	150 ft.	3-speed gear box.
36 in. x 36 in. x 20 ft....	41½ ft.	150 ft.	3-speed gear box.
36 in. x 36 in. x 20 ft....	60½ ft.	150 ft.	3-speed gear box.
42 in. x 42 in. x 14 ft....	48 ft.	147 ft.	
42 in. x 42 in. x 12 ft....	57½ ft.	165 ft.	
48 in. x 48 in. x 8 ft....	51½ ft.	150 ft.	
60 in. x 60 in. x 12 ft....	25 ft.	144 ft.	3-speed gear box.
60 in. x 60 in. x 12 ft....	42 ft.	144 ft.	3-speed gear box.
60 in. x 60 in. x 12 ft....	60 ft.	144 ft.	3-speed gear box.

Thos. Shanks & Co., Johnstone, pay special attention to planers designed with a view to decidedly heavy cutting with such measure of high-speed forward and return strokes as the customer is disposed to provide the requisite power for. Messrs. Shanks now make the beds 1¼ times the length of stroke as against the usual even lengths. The speeds here given are for machines weighing from 5 or 6 tons on the 2½-foot sizes to 100 tons on the 12-foot sizes—2,240 pounds to the ton.

These speeds are permissible when taking four heavy cuts with tools on cross slide, with power to spare for two side tools also cutting.

	B ft.	C ft.	D ft.	E ft.
B = minimum width and	2½	70	20	34
depth capacity of	3½	65	19	32
strongest type.	4½	60	18	30
C = maximum return stroke	5½	55	17	28
speed.	6½	50	16	26
D = slowest cutting speed	7½	45	15	24
for hard metal.	8½	40	14	22
E = highest cutting speed	10	35	13	20
for medium metal.	12	30	12	18

The Mitchell's Reversing Gear Syndicate are introducing a patented device for use in connection with new or existing machines. The peculiar feature of this method is the employment of two heavy flywheels, the momentum of which is transmitted through wide belts at the reversals of the table. By means of gearing the flywheels revolve in opposite directions, at speeds proportionate to the ratio between the speeds of the forward and return strokes.

The wide belts on the flywheels are loose, and are alternately pressed on to the lightly constructed driving pulleys by idler or "jockey" pulleys. Frictional clutches are embodied in the flywheels and are adjusted to such a load as can safely be negotiated by the toothed gearing, the clutches slipping immediately the predetermined duty is exceeded. The cutting and return speeds favored by the Mitchell company approximate to those first mentioned. Alfred Herbert, Ltd., Coventry, were one of the first British firms to manufacture a limited number of types of machine tools in quantity. Turret lathes of fully and semi-automatic types are perhaps the leading line, but the manufacture of milling machines of horizontal and vertical types of the most modern design now form an important branch of the company's business. The success of the firm's policy of giving the fullest consideration to American ideas of methods and designs while at the same time keeping European requirements and conditions in view has been most marked. The hexagonal design of lathe turret is one of their distinctive models which has been appreciated the world over and is applied to a wide range of machines for bar and chucking work. The equipment of the works has, from its inception, included the best known types of tools for repetitive and general work, the toolroom, casting, stores, and other auxiliary systems being organized on corresponding lines. The shop methods are constantly under review with the object of attaining all possible efficiency by taking advantage at the psychological moment of the changes always in progress in the relative merits of, say, milling, planing, grinding, etc. Jigs of the most progressive build have been consistently employed all along, to a degree, and in sizes which were at one time quite exceptional in British practice. All the present models of tools built by the company are designed on lines which admit of utilizing the new alloy steels to the limits which the work being dealt with will admit of. We may add that a new branch works, entirely self-contained as regards equipment is now in process of erection. (Some details of these works will appear later.) Perhaps we may add that a feature too often neglected by otherwise competent concerns, has received appropriate attention from the firm, *i. e.*, the training of a body of competent operators, instructors, and salesmen, a policy which has probably played a far from negligible part in the building up and consolidation of this interesting industrial entity.

JAMES VOSE.

Manchester, Eng., December 29, 1906.

MISCELLANEOUS FOREIGN NOTES.

ALFRED HERBERT, LTD., Coventry, England, are constructing a new shop for building machine tools, as the present prosperous state of the machine tool business in Great Britain has proven their present facilities to be inadequate for the growing demand for their products.

WM. ASQUITH, LTD., Halifax, England., have brought out a new high-speed radial drill. This machine is particularly rigid. The arm can be swung through an arc of 150 degrees, 90 degrees to the front and 60 degrees back. The drill is motor-driven and has eight changes of feed. The maximum height under the spindle is 7 feet 3 inches. The base plate is 7 feet long by 6 feet wide.

Dron & Lawson, Ltd., Glasgow, Scotland, have designed and placed on the market a new bolt cutter, with dies so designed that parallel and taper threads can be cut by the same dies. The internal diameter of the spindle is 7 inches. The machine is motor-driven, the range of the revolutions per minute of the spindle is from 4 to 31, all speed changes being made without stopping the machine.

Machines for the Making of Wire Netting in Victoria.—Consul-General J. P. Bray, of Melbourne, reports that the government of Victoria has accepted a local bid for the supply of eight machines at the price of $5,000 for the manufacture of wire netting. These machines are for the purpose of establishing the industry in the penitentiary at Melbourne and supplying prison-made wire netting to landowners at cost price on long terms of repayment to enable them to cope with the rabbit pest.

The View of German Courts Regarding Ownership of Machinery in Factories.—Consular reports from Germany state that the imperial court has lately in a number of cases held that machinery when installed in a factory or manufacturing plant becomes a fixture, and that therefore a sale upon condition that the title remain in the seller until the machinery is paid for must give way, in case of the bankruptcy of the buyer to the rights of his creditors, and the machinery becomes part of the assets of the bankrupt. The rights of the holders of mortgages on the plant therefore have precedence over the rights of the seller of the machinery, no matter on what terms the sale was made. German manufacturers of machinery are strongly protesting against this decision by the court, calling attention to the fact that this ruling is unjust, the mortgagee receiving rights and security upon which he did not rely when he loaned his money, while the seller of the machinery is deprived of rights for which he expressly contracted, and relying on which he sold the goods and gave the buyer credit. It is claimed that this ruling of the court will greatly impede industrial progress, in that it will greatly limit the credit given by manufacturers and dealers in machinery to capable men who are short of capital and need assistance in the shape of credit in establishing new plants or enlarging those already established. Manufacturers and dealers in machinery who deal with German customers should therefore be very careful about the credit of their prospective customers and should not rely entirely upon the conditions of their contract of sale.

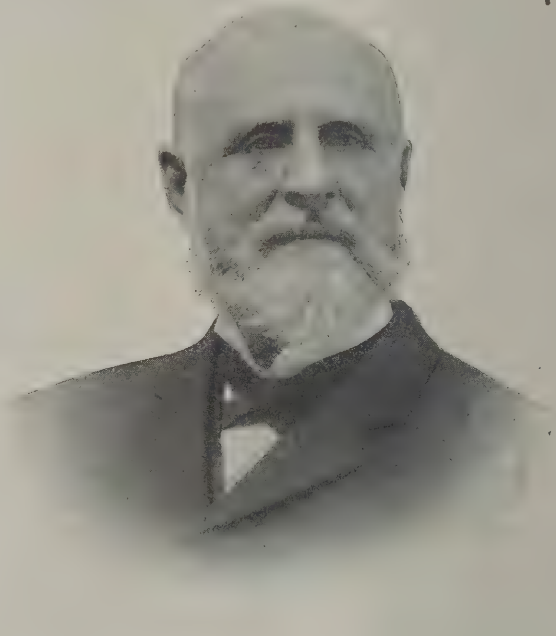
* * *

OBITUARY.

Edward Payson Bullard was born August 18, 1841, in Uxbridge, Massachusetts. After the completion of his apprenticeship in the machinist's trade at the Whitin Machine Works, Whitinsville, Mass., he went to work at the Colts Armory in Hartford, Conn., where he remained until the latter part of 1863. He then entered the employ of Pratt & Whitney working as a machinist until April, 1865. At this time he formed the partnership of Bullard & Prest, carrying on a general machinists' business in the old County Jail Building, Hartford, on which site the Case, Lockwood & Brainard Co. is now located.

In March, 1865, Mr. William Parsons was admitted to the partnership and the name changed to Bullard, Prest & Parsons; Mr. Prest withdrew early in 1866 and the firm became Bullard & Parsons. Vertical drill presses (one of which is now in use at the Bullard works) and pumps were the chief products of the firm. With the idea of moving the business to Norwalk, Conn., Mr. Bullard, in September, 1866, went to that city and interested a number of men in the project, the Norwalk Iron Works Co. being organized for that purpose on October 5, 1866, with Mr. Bullard and Mr. Parsons as members of the board of directors. Changes in the plans were subsequently made, Messrs. Bullard and Parsons withdrawing and continuing their business at Hartford.

The depression of 1868 and lack of capital forced the firm into bankruptcy in August, 1868. A reorganization was effected and, removing to Bristol, Conn., Gray's Foundry (established some years previously by Elisha N. Welch, later more famously known as a great clock-maker) now the site of the Sessions Foundry Company, was purchased by them and operated for a period of one year when the firm dissolved and Mr. Bullard secured the position of superintendent in a large machine shop at Athens, Georgia. The bitter feeling against all Northerners was then at its height and on that account Mr. Bullard resigned his position and went to Cincinnati, Ohio, where he soon became known as a dealer in second-hand machinery. His first sale was of a large number of Lincoln milling machines which he had found in an abandoned Confederate arsenal in Georgia. He then connected himself with the Cincinnati branch of Post & Company, organizing their machine tool department, which has since become the E. A. Kinsey & Co.



Edward Payson Bullard.

Early in 1872 he went to Columbus, Ohio, to assume the position of general superintendent of the Gill Car Works in that city, leaving there in 1874 when the plant was closed down as a result of the panic of 1873. For a short time in 1874 he was superintendent of the Cooper Engine Works at Mt. Vernon, Ohio. Leaving there he established himself in the machinery business on Beekman Street, New York City, in 1875, organizing Allis, Bullard & Company at 14 Dey Street one year later. Mr. Allis withdrew in 1877 and the Bullard Machine Co. was organized, continuing the business at the same address until 1880, when Mr. Bullard secured entire control and continued as E. P. Bullard, dealer.

Recognizing the demand for a high grade lathe, in 1880 he went to Bridgeport, Conn., and engaged Mr. A. D. Laws to manufacture lathes of his design, he agreeing to take the entire output of the plant. Owing to certain unsatisfactory features of the arrangement, Mr. Bullard, in the latter part of the same year, took over the business and styled it The Bridgeport Machine Tool Works, he being the sole owner. In 1883 he designed his first vertical boring and turning mill—a single head, belt feed machine having a capacity of 37 inches, which was later sold to George A. Young, a manufacturer of paint-making machinery in Brooklyn, N. Y. This is believed to be the first machine of this type having such small capacity; boring and turning work of this size having been done in the faceplate of a lathe.

In 1889 business in Bridgeport had increased to such an extent that he discontinued his New York connections and devoted his entire time to the development of the Bridgeport plant; Mr. J. J. McCabe, a member of Mr. Bullard's New York staff, established himself in the old warerooms. The Bridgeport Machine Tool Works was incorporated in 1894 under the name of The Bullard Machine Tool Co., the ownership of stock being entirely in the hands of Mr. Bullard and his sons. Under this name the business is still being carried on.

Mr. Bullard died suddenly December 22 at Braidentown, Florida, where he had gone a few days previously for his regular winter sojourn.

PERSONAL.

C. H. Rhodes, formerly manager of the Grand Rapids branch office of McDonnell, Stocker & Co., Chicago, has been made sales manager of the Wilmarth & Morman Co.

R. H. Mitchell has resigned from the Olds Motor Works to accept the position of superintendent of the machine department of the Kansas City Motor Car Co.

E. T. Gorham, for over seven years superintendent of the Oliver Machinery Co., Grand Rapids, Mich., became a stockholder and director of the Wilmarth & Morman Co., January 1, and will fill the position of shop manager.

Asa M. Mattice has announced the discontinuance of his business as consulting engineer with offices in New York City and his assumption of the management of the works of the Walworth Mfg. Co., South Boston, Mass., beginning January 1, 1907.

Edwin W. Beardsley, formerly chief draftsman of the Rockwell Engineering Company, New York, more recently of Waterbury, Conn., has taken charge of the building division in the engineering department of the American Brass Co., of Waterbury, who operate a number of brass mills in the Naugatuck Valley.

William J. Clark, of New York, was appointed delegate from New York State by Governor Hughes to attend the national convention for the extension of foreign commerce of the United States which was held at Washington, D. C., January 14, 1907. Mr. Clark is general manager of the foreign department of the General Electric Co. and for many years has been interested in the conditions of foreign commerce.

H. J. Lamborn has been appointed superintendent of the power and plant of the Yale & Towne works, Stamford, Conn. The position is a responsible one, involving, as it does, the management of all the steam and electrical apparatus, the supervision and designing of new buildings, and in general everything relating to steam and electric power and distribution, heating, ventilation, water supply, drainage, fire department, up-keep of buildings and general repairs.

* * *

FRESH FROM THE PRESS.

The Engineering Quarterly of the University of Missouri. 80 pages 6½ x 9¾ inches. Published four times during the scholastic year by the Engineering Society of the University of Missouri, Columbus, Mo. Price, $1.00 per year.

The first issue of the Engineering Quarterly contains among other articles one on Electric Drive, by Prof. H. B. Shaw; the Steam Turbine with Superheated Steam, by E. A. Fessenden and J. R. Wharton; Test of Reinforced Concrete Beams, by W. K. Seitz; Note on the Allowance of Decreased Efficiency by Prof. Arthur M. Green, Jr., etc.

Steel Square Pocketbook. By Dwight L. Stoddard. 159 pages, 3¼ x 5 inches. 150 cuts. Published by the Industrial Publication Co., New York. Price, 50 cents.

This is one of several treatises on the use of carpenters' steel squares, and of course is of more technical interest to carpenters than any other class of mechanics. It is an interesting work to look through and see the multitudinous use to which the ordinary carpenters' tool can be put and the surprising problems that can be solved in a moment's time by its application. To the student of geometry the use of the steel square is of almost fascinating interest. The work is of strictly practical value and is one that can be recommended for the class of mechanics to whom it will appeal, that is, carpenters and builders.

Machine Design. By Prof. C. H. Benjamin. 202 pages, 5 x 7½ inches, published by Henry Holt & Co., New York. Price $2.00.

This work is based on "Notes on Machine Design" published by the author in 1895. The original notes have been entirely rewritten and the mathematical work revised and considerable new matter has been added, much of which represents the author's experience in his direction of the laboratory work of the Case School of Applied Science, Cleveland, Ohio. We know of no work on machine design which can be more heartily recommended to the average student than this. The author has aimed to present "what the student needs to learn before graduation, as this is what he needs to remember afterwards." In other words, he has presented the essentials, leaving off the frills with which too many works on machine design are "ornamented." The work has the characteristics of Prof. Benjamin's writing in general; that is, clearness and simplicity. It is brought up to date, containing, for example, a summary of the paper on the collapsing strength of lap-welded steel tubes presented by Prof. Stewart before the spring meeting of the A. S. M. E., 1906. The matter on the bursting strength of cast-iron cylinders is particularly valuable. A running review of the chapters will give an idea of the contents. These are in order: Units and Tables; Frame Design; Cylinders and Pipes; Fastenings; Springs; Sliding Bearings; Journals, Pivots and Bearings; Ball and Roller Bearings; Shafting Couplings and Hangers; Gears, Pulleys and Cranks; Fly-Wheels; Transmission by Belts and Ropes.

Self-Propelled Vehicles. By Prof. J. E. Homans. 598 pages, 5½ x 8½ inches. 399 cuts. Published by Theo. Audel & Co., New York City. Price, $2.00.

This is the fifth edition of a popular work on the automobile, which has been revised and partly rewritten. As is consistent with the present development of the automobile, by far the greater part of the work is given up to a consideration of the characteristics of the gasoline vehicle. A valuable feature is three double-page diagrams showing side sectional elevation of an American four-cylinder touring car; the plan of an American gasoline vehicle showing the engine and operative mechanism (being a half-tone view looking down upon the chassis); and the third diagram is of the cranks and cycles of multiple cylinders showing the relation of 2-cylinder, 3-cylinder, 4-cylinder and 6-cylinder cranks, together with their working strokes. The book as a whole is well gotten up, copiously illustrated, clearly written and is just the kind of a work that will appeal to thousands of people interested in the mechanical features of the automobile either as users, prospective users, or mechanics. About the only criticism to be offered is that some of the cuts are not strictly first class in execution, but all of them are clear enough to be easily understood and this, of course, is the principal consideration in a low-priced book. Enough space is given to theoretical treatment of principles of the gasoline motor to satisfy the amateur theorist. Considerable space is given to the electric systems used for ignition. The bulk of the work is strictly practical and, as intimated, it contains a large amount of practical information on the subject.

Electrical Engineering. By E. Rosenberg, translated from the German by W. Haldane Gee and Carl Kinzbrunner. 360 pages, 6 x 9 inches. 333 cuts. Price, $2.00 net.

This work is intended to be an elementary textbook, suitable for persons employed in mechanical and electrical engineering trades and for elementary students of electrical engineering, etc. It had its origin in a series of lectures delivered by the author some years ago to the workmen and staff of a large German manufacturing concern. The work therefore, deals with fundamental principles and describes in common language various electrical apparatuses and the principles governing them. It begins with a dissertation on electric phenomena, explaining electromotive force, magnetism, electric units, electric measuring devices, electromagnets, etc. Chapter III. takes up the continuous-current dynamos, beginning with the ring armature, and describes the various types of continuous-current machines. It also gives considerable space to the faults and troubles likely to be met with in generator and motor operations. It describes motors used for various mechanical purposes, *i. e.,* machine tool driving, cranes, hoisting, electric traction etc. Accumulators receive attention, various types being described and illustrated, and a chapter is given on electric lighting. Chapter VIII. is on alternating currents, giving a good elementary treatment of the subject, following which is a chapter on alternators, measuring instruments used with alternating currents, converters, commutator motors, induction motors, etc. The work is undoubtedly one that contains a great deal of valuable information for the non-technical man, whether he be a student, mechanic, railway man, or other worker.

The Engineering Index. Volume IV., 1901-1905 inclusive. Edited by H. H. Suplee and J. H. Cuntz, with Chas. B. Going. 1234 pages 6½ x 9½ inches. Published by the *Engineering Magazine,* New York. Price, $7.50.

This work aims to be an index of articles of permanent value that have appeared in the world's engineering publications, and to give a brief succinct description of each article, stating number of words, cuts, author, name of publication, date, etc., in the least possible number of words. The list includes about 260 weekly, semi-weekly, monthly, semi-monthly, quarterly and yearly publications which are regularly reviewed. The work contains approximately 35,000 subjects, indexed and classified with the idea of making it easy, for a user who has in mind a definite item or article, to locate it. It is also prepared so far as possible to meet the convenience of users who are investigating a certain subject and desire to be informed on all the articles that have been published pertaining to that subject. The work is uniform with the previous engineering indexes that have been published, these being Vols. I., II. and III., beginning with 1884. The succeeding volumes will be published annually. The work is a rearranged compilation of the regular monthly index found in the *Engineering Magazine,* already well known to many of our readers. It is a work to be highly commended, for with the enormous multiplication of subjects and great extent of technical literature at the present time it is almost hopeless for any engineer to keep in touch with all matter pertaining to his business, which is published in the world's technical literature, especially if he is remote from the large centers. The Engineering Index will be to him a time-saver and, therefore, a life-saver, if he would keep in intimate touch with the literature concerning his profession. Needless to say it is indispensable for engineering libraries.

Pocketbook of Mechanical Engineering. By Charles M. Sames. 203 pages, 4 x 6½ inches (regulation pocketbook size page), and 40 figure numbers. Bound in flexible leather. Published by the author, Jersey City, N. J. Price $2.00.

This work is a pocketbook that is a pocketbook, *i. e.,* one that can be carried comfortably on the person. It is no reflection on their general excellence to say that most of the other so-called "pocketbooks" are so by courtesy only; their Falstaffian proportions quite prohibit convenient transportation, save it might be in a handbag. The book in review is the second edition of what is probably the most meaty book of its size ever published on the subject of mechanical engineering. While containing less than 200 pages of actual matter (excluding index) it actually contains the gist of several large volumes as usually presented. In fact, it would be difficult to select a half dozen mechanical works (excluding other pocketbooks) which would contain all the essential matter found therein. The matter is set in 6-point with narrow margins and is boiled down to almost the last degree of concentration. The new edition contains additional matter on strength of materials, energy and transmission of power, heat and heat engines, hydraulics and hydraulic machinery, shop data, electrotechnics, etc. The same subjects are treated at length in the body of the work, which also includes chapters on mathematics and materials. Two pages are devoted to an explanation of symbols and abbreviations used in the text; this feature could very profitably have included other symbols even though they were not used in the work, as, for example, the complete Greek alphabet, both capitals and small letters, and this criticism applies to handbooks in general. Few engineers are Greek scholars and they are often embarrassed in reading formulas to give the names of some of the Greek letter symbols occasionally used. This is not of so much consequence, however, as that of establishing in general use standard symbols which shall have certain definite meanings, and that is just what the handbooks can greatly help to do.

NEW TRADE LITERATURE.

J. W. Kerr Co., 43 West Washington St., Chicago, Ill. Pamphlet giving dimensions and prices of machinists', electricians' and woodworkers' tools.

The Crocker-Wheeler Co., Ampere, N. J., have sent us a 1907 calendar, printed in colors, showing a view of the main office and works of the company's plant at Ampere.

The Smith Countershaft Co., Boston, Mass. Catalogue illustrating and describing the one-belt reversing countershaft and pointing out some of the advantages obtained by its use.

Sprague Electric Co., 527 West Thirty-fourth Street, New York City. Flyer No. 225 showing a few of their many combinations of hoists, carriages and cranes. Pamphlet describing and illustrating the electric equipment of a modern hotel.

CONTENTS FOR FEBRUARY.

PATTERSON, GOTTFRIED & HUNTER, LTD., 146 Centre St., New York City. Catalogue No. 77 for dealers and jobbers, illustrating and describing the various products of machinery and hardware which they have for sale.

THE WALTHAM WATCH TOOL CO., Springfield, Mass. Pamphlet giving specifications for their new No. 0 Van Norman "Duplex" milling machine and describing profiling device and index centers for use with this machine.

WM. DAWSON & SONS, LTD., "Cannon House," Bream's Buildings, London, England, have issued a directory for 1907 of English and Foreign newspapers, magazines, etc., together with foreign and domestic subscription rates for same.

JENKINS BROS., New York. Catalogue for 1907 on Valves and Packing. Description of their product, including dimensions and prices, is given. The constant increase in steam pressures has made necessary an increase in the manufacture of valves for extreme pressures, some of which are described herein.

THE DAVIS SEWING MACHINE CO., Dayton, Ohio. Catalogue of the Davis screw-slotting machine. This machine is semi-automatic, requiring only a boy or girl to feed the screws; it will slot about 18,000 screws in ten hours. It can be fitted up to slot any number of kinds of screws and sizes of heads up to ½-inch diameter.

REINFORCED BRAZING AND MACHINE CO., 1109 Arrott Building, Pittsburg, Pa., have issued a pamphlet entitled "Don't Throw Away Your Broken Castings," telling of the new Richardson method by which iron castings may be reinforced and brazed so that the tensile strength will be made even greater than it was originally. Letters from various firms testifying to the excellence of the work done by this method are included.

WARD-LEONARD ELECTRIC CO., Bronxville, N. Y. Catalogue showing the various applications of the Ward-Leonard rheostats, circuit breakers and resistance units. Some of these have been installed in the Weston Electrical Instrument Co. of Newark, and in the plant of the Lanston Monotype Machine Co. for use with their casting machines. Crocker-Wheeler Co., Niles Tool Works, Northern Electric Mfg. Co. and many other well-known firms are using this electric apparatus in connection with their machines.

THE AMERICAN LOCOMOTIVE CO., 111 Broadway, New York City, have recently published the fifth of a series of pamphlets on locomotives. This pamphlet is devoted to ten-wheel-type locomotives weighing less than 150,000 pounds, and will be followed shortly by another showing the heavier designs of this type. The pamphlet illustrates and describes 21 different designs of ten-wheel locomotives ranging in weight from 64,000 to 150,000 pounds and adapted to a variety of road and surface conditions. The series now includes pamphlets on the Atlantic, Pacific, consolidation and ten-wheel types, and copies of these may be had upon request.

As befits the season which brings us the anniversary of their births, the February issue of the *Century* devotes a goodly proportion of its pages to Washington and Lincoln. "The Washington-Craigie-Longfellow House" at Cambridge is charmingly described by Francis LeBaron, and the text is enriched by reproductions from paintings, miniatures and photographs. Bishop Potter writes of "The Graves of Three Washingtons," and Mr. W. M. Sloane gives us "Von Moltke's View of Washington's Strategy." The Lincoln interest is advanced by Silas W. Burt's Reminiscences of "Lincoln on His Own Story Telling"; "Why Lincoln Was Not Renominated by Acclamation" is told by Clark E. Carr, and a sympathetic glimpse of Lincoln's character is given in Myrta Lockett Avary's "A Lincoln Souvenir in the South."

The usual quota of fiction rounds out the number and several charming full page illustrations add to its beauty.

MANUFACTURERS' NOTES.

ON and after January 1, 1907, the American Society of Mechanical Engineers will be located in the new United Engineering Societies Building, 29 West 39th St., New York City.

THE WARNER & SWASEY CO., Cleveland, O., have opened a New York office at 149 Broadway (Singer Building), Room 521. Mr. H. L. Kinsley is in charge.

THE CLEVELAND CRANE & CAR CO., Wickliffe, Ohio, recently received an order from the Empire Bridge Co., of Pittsburg, Pa., for the entire crane equipment of the Elmira, N. Y., bridge plant.

Messrs. Vaghi, Accornero & Co., machinery dealers in Milan, Italy, have removed their offices and show rooms to Corso Porta Nuova 34, where they have secured additional facilities and room required for their increasing business.

E. P. DUTTON & CO., 31 W. 23d St., New York, have made arrangements with Archibald, Constable & Co., London, England, for the American rights of Prof. C. H. Benjamin's new book, "Modern American Machine Tools." This book was briefly reviewed in the January issue.

THE MIAMI VALLEY MACHINE TOOL CO., Dayton, Ohio, was incorporated in January, and will manufacture the "Miami Valley Lathe" and 12- and 14-inch sensitive drill presses. The incorporators are S. D. Conover, president; W. D. Foster, vice-president; P. P. H. Conover, secretary, and H. T. Chamberlain and E. R. Evinger.

THE NILES-BEMENT-POND CO., Trinity Building, 111 Broadway, New York, have appointed Messrs. Harron, Rickard & McCone, 436 Market St., San Francisco, Cal., agents for their entire line of machine tools, hammers, hydraulic machinery and electric traveling cranes for the states of California, Nevada and Arizona.

THE ABRASIVE MATERIAL CO., Philadelphia, Pa., are shipping wheels to all parts of the world, one of their latest orders amounting to between seven and eight hundred wheels of various sizes, total weight of which was between four and five tons. In addition to this, shipments have been made to England, Germany, Austria, Japan and Siberia.

THE WESTERN ELECTRIC CO., Hawthorne, Ill., exhibited at the Electrical Show at Chicago, Ill., in January a large water color painting of their plant at Hawthorne, as well as samples of their product, such as American transformers, Thomas high-tension insulators, electro-insulating material, Western Electric Co.'s arc lamps, etc. Special features of their exhibition were an indestructible field coil for railway motors and a new induction motor.

THE LUMEN BEARING CO., Buffalo, N. Y., have established a Canadian branch at Toronto Junction under the management of Mr. N. K. B. Patch. It is a modern plant equipped especially for foundry work, with a capacity for 7,000 pounds of castings a day. It has the necessary crane equipment, etc., for handling castings up to 3,000 pounds. The company will continue to make its well-known "Lumen" bronze, as well as manganese bronze, brass and aluminum castings.

THE YALE & TOWNE MFG. CO., Stamford, Conn., in December announced to their superintendents and foremen, through Mr. Henry R. Towne, president, an increase of wages and piece rates to its employes which number over 3,000. Each individual rate will be reviewed and where necessary will be adjusted, due allowance being made for previous advances which have already been made since December 1, 1905. The proposed advances, with those already made, will make a total of about $120,000 per year to be distributed among the employes by changes in day rates and piece rates.

J. E. SNYDER & SON, Worcester, Mass., well-known manufacturers of upright drills, are building a new shop 90 x 170 feet on the corner of Dewey and Parker Streets. It is of cement construction, rock face, one story high, with coal sheds, etc., additional, and gives a total floor space of 24,000 square feet—a little more than three times what is available in their present quarters. A number of new tools have been ordered and the shop will be equipped with traveling cranes and other labor and time saving appliances. The firm expect to be in their new quarters next May.

THE BARRIETT ELECTRIC MFG. CO., Cincinnati, Ohio, who have been manufacturing direct-current motors and generators for several years, have now started to manufacture a full line of alternating-current induction motors and have sent the first shipment of these to Mexico. During the past year the company have designed six new machines and have increased their output considerably. The Barriett motors can be bought in all large cities from New York to San Francisco, and have a wide range of usefulness, but are made especially for factory service.

THE BIRDSBORO STEEL FOUNDRY & MACHINE CO., Birdsboro, Pa., have for the past year or so been making a specialty of casting open-hearth steel pipe castings suitable for high-pressure superheated steam. They have designed and built what they call a special tri-facing machine to facilitate the production of this class of work. This machine is capable of boring, facing and truing up a T or L fitting in one operation without in any way disturbing the original setting of the casting. It is said to increase the finishing capacity 200 per cent. The weight of the machine is about 50,000 pounds and it is equipped with a 30-horsepower motor to drive the three heads. It has a capacity for handling fittings of from 6 inches to 30 inches in diameter. The company will build another addition to their present power plant and orders have been placed for a 100-horsepower Harrisburg engine, one 300-K.W. Westinghouse generator and two 250-horsepower boilers.

THE TECHNICAL PUBLICITY ASSOCIATION devoted its meeting of December 20, at the Aldine Association rooms, 111 Fifth Ave., New York, to the subject of "The Value of Circulars and Printed Matter." Mr. Frank Vreeland, art editor of the American Printer, spoke of the commercial value of beauty in typography, and Walter Gilliss, president of the Gilliss Press, New York, made some remarks about limited editions. The companies represented at the dinner by members of the association—which is confined to those connected with the advertising departments of machinery manufacturing industries—were as follows: Ingersoll-Rand Co., T. R. Almond Mfg. Co., Pope Mfg. Co., H. W. Johns-Manville Co., Yale & Towne Mfg. Co., John A. Roebling's Sons Co., American Locomotive Co., General Electric Co., Patterson, Gottfried & Hunter, New York Edison Co., M. H. Treadwell Co., Crocker-Wheeler Co., A. S. Cameron Steam Pump Works, and Lidgerwood Mfg. Co.

HILL, CLARKE & CO., INC., 156 Oliver St., Boston, Mass., have just rearranged their office and showrooms, which adds greatly to their

RAILWAY MACHINERY.

A special edition of MACHINERY devoted to Locomotive and Car Equipment and Mechanics.

March, 1907.

ELECTRIC RAILWAY MACHINERY AND APPARATUS.—1.

WM. BAXTER, JR.

Wm. Baxter, Jr.

In this series of articles it is proposed to explain the construction and operation of electric railway motors and generators, the controllers and other apparatus used to operate the motors and the switchboards, and accessories used in the power station to properly control the operation of the generators. The description will include alternating current motors and apparatus, as well as the direct current, and will embrace all the latest developments and improvements in the electric railway field, particularly for heavy railroad work.

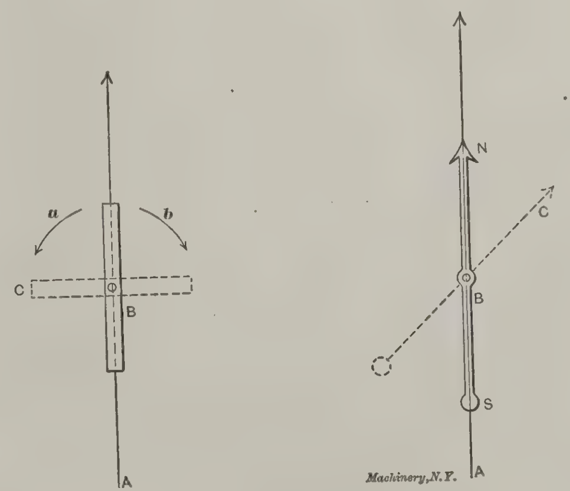
In order that the explanations and descriptions of railway machinery and apparatus may be clearly understood it will be necessary to start at the bottom and explain the elementary principles of electricity and magnetism upon which their operation depends. To fully elucidate all these principles at the start would require a considerable space, and the reading would become monotonous for the majority of men; therefore we have decided to explain at present only as much of the elementary principles as may be necessary to enable the reader to fully understand the discussion of the actual machines and apparatuses we describe, leaving for the future the consideration of principles involved in the operation or construction of other apparatuses. In this way the explanation of machines and apparatuses and of the principles on which they operate, or upon which their construction depends, will be carried along together; the subject will be developed progressively from the beginning to the end, thus presenting new features in the theoretical, as well as the practical part of the subject from first to last. It is believed that this way of treating the subject will make it more interesting than to give all the theoretical part at the start, and it will certainly be more instructive, as principles will be explained just before machines or apparatuses in which they are used are described; thus the reader will have the principles fresh in his mind, and will not be compelled to turn back to early installments of the series to read over the theoretical principles a second time so as to refresh his mind.

Electrical Flow not Perceptible with Ordinary Means.

From the appearance of a wire no one can tell whether there is an electric current flowing through it or not, as it does not change in color, size or shape, in so far as can be determined by an ordinary inspection. As a matter of fact, however, the diameter of the wire is increased, but this increase is so small that it cannot be detected except with measuring instruments of the finest type, and even then only if the current flowing through the wire is very strong. The diameter of the wire is not increased through any direct effect of the electric current, but simply because the latter in traversing the wire generates heat and the latter expands the metal. The amount of heat generated in the wire per foot of length depends upon the strength of the current, upon the diameter of the wire and upon the metal it is made of. In any case, the stronger the current the greater the heat. If we take a current of a given strength the heat it will generate in a wire will depend upon the diameter of the latter, and will increase as the diameter is reduced, and reduce as the diameter is increased. If we take pieces of wire of iron, copper, lead, tin and several other metals, all of the same diameter, and join them together end to end and pass an electric current through the lot, we will find upon making a careful test that the amount of heat generated in one foot of wire of the several metals is not the same but varies to a decided extent. The heat generated in the copper wire will be less than in any of the other wires, being only about one-seventh of that generated in the iron, and about one-twelfth of that in the lead.

Generation of Heat in Conductor.

To explain the generation of heat in the wires, and also the difference in the amount of heat generated in the different metals, we have to go back to the principle of the conservation of energy, which governs the action of electricity as well as all other natural forces. The explanation is simply this: It requires energy to force an electric current through a wire, and this energy cannot be destroyed—it can only be transformed, or changed into another form of energy. Electricity is a form of energy and the portion of this energy that is absorbed in forcing the current through the wire is transformed into heat, which is another form of energy. The fact that more heat is generated in forcing the current through the lead wire than through the iron shows that the lead resists the flow of the electric current more than the iron; and the copper in which so very much less heat is generated only offers a small portion of the resistance of the iron and lead.



Figs. 1 and 2. Principles of Electric Flow.

All Substances Resist the Flow of Electricity.

Every substance known resists the flow of electricity through it, thus all substances are said to possess electrical

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William Baxter, Jr., was born in Troy, N. Y., in 1854. He was given an academic education and acquired considerable valuable experience designing steam and hydraulic machinery for his father, William Baxter, between 1860 and 1880 a well-known builder of engines and machinery. He entered the electrical engineering field in the early eighties, and since has devoted himself to this work and to elevators. He was a pioneer motor inventor and manufacturer, and invented the first enclosed arc lamp about 1882; he put stationary motors on the market in 1886 and railway motors in 1890. He was the first to design and place on the market the single-reduction type of railway motor now universally used on trolley cars. Previous to that time, motors were double-reduction with an intermediate shaft between the motors and car axle, this arrangement being used to obtain sufficient power to operate the car without making the motor too heavy. Since 1895 Mr. Baxter has been a consulting engineer and has written extensively for the various mechanical and electrical journals on nearly all the industrial applications of electricity, and on elevators of all kinds.

resistance. Some substances permit the electric current to pass through them freely, and are spoken of as electric conductors, while other substances resist the flow of current so much as to practically stop it entirely. Such substances are called non-conductors, or insulators. The resistance that any substance offers to the flow of an electric current is measured by a unit called an ohm, and the same unit is used whether the material be of the highest order of conductivity or the lowest. The resistance of all substances that are used as conductors, is so low that it is measured in a few hundred ohms, and in some cases by very small fractions of one ohm; but substances that are of such high resistance as to come under the head of insulators are measured in millions of ohms, or in megohms, this latter word designating one million ohms. All forms of matter resist the flow of electricity, whether they be solid, liquid or gaseous, and the only difference between them is in the amount of resistance they offer, which in some is exceedingly small while in others it is very great. The conductivity of copper and silver, which are the best conductors is many billion times greater than that of glass or mica, which are among the poorest conductors, being so poor that for all practical purposes they totally prevent the passage of a current through them, and on that account are classed as insulators.

Inasmuch as a wire resists the flow of an electric current through it, it is natural to conclude that the longer the wire the greater the resistance, and this conclusion is entirely correct. It is also natural to infer that the smaller the wire the greater the resistance, and this is also true. The resistance of a wire is increased by making it longer or smaller. It is for this reason that electric motors and generators of large capacity are wound with larger wire than smaller machines.

Ohm, Ampere and Volt.

In the foregoing we have stated that the resistance of a wire is measured in ohms, but this statement by itself is not very comprehensive, for it will naturally be asked, what is an ohm? What amount of resistance does it represent? An ohm is an amount of resistance permitting a certain amount of current to pass through the conductor, when the current is impelled by a certain amount of force. The strength of the current is measured by a unit called an ampere. The current is driven through the conductor, against the resistance, by a force or pressure that is called electromotive force, which means the force that moves the current. Electromotive force is measured by a unit called a volt. The relation between the ohm, ampere and volt is such that an electromotive force of one volt will force a current of one ampere through a conductor having a resistance of one ohm. If the resistance of the conductor is two ohms, one volt of electromotive force will only force one-half of an ampere of current through it, and if the resistance is ten ohms, one volt of electromotive force will drive one-tenth of an ampere through it. On the other hand if the resistance of the conductor is half an ohm, two amperes of current will be forced through it by an electromotive force of one volt, and if the resistance is reduced to one-tenth of an ohm, one volt of electromotive force will drive ten amperes through it. From all this it will be seen that if we know the resistance of a conductor, and the electromotive force acting on it, we can easily calculate the current strength, by simply dividing the electromotive force by the resistance. Again, if we know the electromotive force and the current strength all we have to do to obtain the resistance is to divide the electromotive force by the current. Finally if we know the strength of the current and the resistance of the conductor we can obtain the electromotive force that impels the current by simply multiplying the resistance by the current. In every case we have to take the current in amperes, the resistance in ohms and the electromotive force in volts.

Ohm's Law the Foundation of Electrical Science.

The foregoing is what is known as Ohm's law and is the foundation stone of electrical science, and should be thoroughly understood by every one who desires to acquire information on the subject. In mathematical language the resistance of a conductor is represented by R, the strength of current is represented by I and the electromotive force by E, and Ohm's law is written in the three following forms:

$$E = I \times R \qquad I = \frac{E}{R} \qquad R = \frac{E}{I}$$

Translated into plain English these three forms mean that: The electromotive force in volts is equal to the current, in amperes, multiplied by the resistance, in ohms: The current, in amperes, is equal to the electromotive force, in volts, divided by the resistance, in ohms: the resistance, in ohms, is equal to the electromotive force, in volts, divided by the current, in amperes.

The above explanation of electrical units while showing clearly the relation between volts, amperes and ohms, is not entirely satisfactory to the man who knows nothing about electrical science, because it gives no means by which he can form a correct conception of the magnitude of these units. A mechanic can readily realize the magnitude of a foot-pound when he is told that it represents the energy required to lift one pound one foot high. He can understand this because he knows the magnitude of one pound as well as that of one foot. To be able to realize the magnitude of the electrical units it is necessary to know what they are equivalent to in other well-known units, and on this point we will throw light in what follows: Work cannot be measured by pounds alone, or by feet alone, because it is the product of weight multiplied by the distance through which it is moved. In the same way electrical work or energy cannot be measured by amperes or volts alone as it is equal to the product of the amperes of current by the volts of electromotive force that drives the current through the conductor. The product of one volt by one ampere is called a watt, and is an amount of energy that is equal to very nearly 44.24 foot pounds, that is, to the mechanical energy required to lift one pound 44.24 feet high. This connecting link will enable any one to soon form in his mind's eye a relationship between the electrical units of measurements and the foot pound, or horsepower. The magnitude of the ampere by itself can also be obtained from the amount of chemical action it can produce, but this information is of no service to any one not versed in chemistry, and not at all necessary in purely mechanical work.

Electric Currents Flow only in Circuits.

Electric currents can only flow in an endless path or circuit, that is, they must return to the point from which they start. The path in which an electric current flows is called an electric circuit, and it may be more readily understood by comparing it to the piping system in a steam heating plant. In such a plant the steam passes out of the boiler into a pipe through which it is conveyed to the radiators, and after passing through these it returns to the boiler, to be again generated into steam and pass out on its mission of distributing heat. In the electric circuit, a generator is provided, which in the case of a call bell or other small apparatus may be a battery, and in large work a machine driven by steam or other power. This generator develops the current and the electromotive force required to force it through the circuit, and the current after passing through the circuit returns to the generator without having been diminished in the least. If the current passing from the generator into the circuit has a strength of ten amperes, the current returning from the circuit to the generator will also have a strength of ten amperes; it can neither increase nor decrease in its passage through the circuit, and all the generator has to do is to keep it moving, or in other words to generate the electromotive force necessary to overcome the resistance of the circuit.

There is one difference between the steam pipe circuit above referred to and the electric circuit which is a decidedly important one. In the former if the pipe is ruptured at any point the steam will escape into the air until the flow is cut off by the closing of valves or other means; but if an electric circuit is ruptured at any point the current will at once stop flowing. The effect is the same as if in the steam pipe circuit, the ends of the broken pipe were closed up at once so as to prevent the escape of steam.

An electric circuit must be made up of conducting material, but it is not necessary that all of it be of the same material.

A portion may be copper wire, another portion iron wire, a third portion may be a conducting liquid or some form of solid that cannot be drawn into a wire, such for example as a rod or plate of carbon. The current that will flow through any circuit is proportional to the total resistance of the circuit, and is determined by dividing the volts of electromotive force developed by the generator by the total resistance of the circuit in ohms, the quotient being the current in amperes.

Need of Insulation.

In order that an electric current may be confined to any particular circuit, it is necessary that the matter that surrounds that circuit be of such high resistance as to come under the head of an insulator. Air is such a form of matter, therefore, if a circuit made of copper wire is suspended in the air the current will be confined to it. If, however, the wire is laid on the ground all the current will not be confined to it, but some will pass into the ground at points near where the current leaves the generator, and will flow through the ground to other points near the end of the wire through which the current returns to the generator, and at these points it will re-enter the wire, so that all the current that passes out of the generator may return to it. In practice wire circuits are strung on wooden poles so as to keep the wire from coming in contact with the ground. If these poles were perfectly dry they would prevent the leakage of current through them from the wire to the ground; but they cannot be kept dry enough in practice to act as perfect insulators, and on that account glass, and porcelain supports, called insulators, are provided to support the wire. These insulators are far more effective than the wooden pole alone, in part because the material of which they are made is a much better insulator, and in part because they are made so as to prevent the formation of a continuous path of water, or moisture, between the wire and the ground. Water if perfectly pure is one of the highest insulators, but the water that settles on the poles that carry electric wires, is not pure, and instead of being an insulator is a good enough conductor to permit a considerable amount of current to pass through it.

In the construction of electrical machines and apparatuses of various kinds it is necessary to wind wire in the form of coils and to pass the electric current through these. If such coils were made of bare wire, they would fail to perform their work properly, because the current would not follow the wire from one end of the coil to the other, as it should do, but would leak from one turn to the other through the many points of contact, and thus reach the end of the coil through the paths of least resistance. To prevent the current from taking this short cut path through the coil, the wire is covered with a layer of cotton or silk thread, both of which materials are good insulators, and in this way the only path through which the current can flow is the wire itself. In some cases, where the current is forced through the circuit by a high electromotive force, the cotton or silk insulating covering is made a more perfect insulator by being saturated with a varnish or insulation compound. These insulating compounds are not necessarily better insulators than the cotton or silk, but they improve the insulation by keeping out the moisture of the air.

Uncertainty as to the Real Nature of Electrical Flow.

In the foregoing we have spoken of electric current as flowing through a circuit, and also as starting from one side of the generator and returning to the other. This way of treating the subject naturally leads the reader to infer that it is a well settled fact that electricity flows through a circuit, like water through a pipe, and that we not only know this much to be a certainty, but that our knowledge on the subject is so complete that we can even determine the direction in which the flow takes place. As a matter of fact, however, we do not know whether electricity flows in currents or not, much less do we know that it flows in a certain direction. If we knew all this we would know just what electricity is, or at least we would know it to be a form of matter, for if a thing can flow in a stream it must be something tangible. Now we do not know whether electricity is a form of matter or simply a form of energy. We talk about electric currents because electricity in a circuit acts as if it were flowing through it, and it helps the imagination enormously to look upon it as actually flowing like water through a pipe. As we do not know whether there is such a thing as an electric current we certainly cannot know in what direction it flows, assuming that there is a current; but it is the universal custom to talk about electricity as if it flowed through the circuit, and the direction of flow is determined by certain effects that are produced, which will be explained in what follows.

Principles of Electrical Flow.

In Fig. 1 let the line *A* represent a wire stretched in a horizontal direction, and let *B* represent a short bar made of a piece of soft wrought iron. Let *B* be suspended by a string fastened to a hook at its center, so that the bar may also be in a horizontal position. If there is no current of electricity flowing through wire *A*, we will experience no difficulty in bringing *B* into line with *A*, directly above it. This much we can accomplish by simply twisting the string slightly in one direction or the other. After we have brought *B* and *A* into line, if we connect *A* in an electric circuit so that a current will flow through it, we will notice that the instant the circuit is closed, *B* will swing around in the direction of either of the arrows *a* or *b*. If the current is weak the movement of *B* may be slight, but if the current is sufficiently strong *B* may swing around until it is nearly at right angles to *A*. If we try to return *B* to a position parallel with *A*, we will find that a force resists the movement, and that as long as the current passes through *A* we cannot make *B* stay parallel with the wire except by holding it. From this experiment we find that when an electric current passes through a wire, a force is developed around the wire that is capable of swinging an iron bar around in a position forming an angle with the wire. This force is called magnetism, and it is developed by the electric current flowing through the wire and is not influenced in any way by the material of which the wire is made, in fact any form of electrical conductor will accomplish the same result. If we were to substitute for the wire a glass tube filled with salt water, the result would be the same. The effect is not confined to any particular side of the wire carrying the current but acts all around it. If *B* were mounted on a pivot and placed under the wire it would be moved around the same as when suspended above, and if *B* were mounted on a horizontal spindle so as to be held on either side of the wire the action would still be the same. The action is not confined to any particular part of the wire either. If *A* were a mile, or one hundred miles long and were traversed by an electric current, it would act upon *B* in the same way at all points from one end to the other. This shows that when an electric current flows through a wire, or other conductor, the surrounding space becomes the seat of a magnetic force, that is, an electric current flowing through a circuit is surrounded by a magnetic envelop.

We stated above that when the current is passed through wire *A*, *B* will swing either in the direction of arrow *a* or arrow *b*. This is true of the first experiment, but if the current is suspended, and after *B* swings back parallel with *A* and comes to rest, the current is again turned on, then *B* will swing in the same direction it did the first time. The explanation of this is that in the first experiment *B* being a piece of soft iron, was free from magnetism, but as soon as the current was turned on and the bar was thrown around to the angular position, it was magnetized from being immersed in the magnetic envelop surrounding the wire. Soft iron cannot retain more than a minute trace of magnetism after it is removed from the influence of a magnetic force, but even this minute trace is sufficient to determine the direction in which the bar will swing when the current is turned on the second time, providing *B* is brought into a position exactly parallel with *A*. This shows that there is a fixed relation between the direction in which the current flows and the direction in which the magnetic force surrounding the current acts, for if there were no fixed relation, the direction of swing of *B* on the second trial would be wholly uncertain. This relation between the direction of the current and of the direction in which the force of the magnetic envelop acts can be more fully illustrated by the aid of Fig. 2, in which

the soft iron bar *B* is replaced by a magnetized needle *B*. A magnetized needle is made of hardened steel, and after being properly magnetized, retains its magnetism permanently. Magnet needles, as everyone knows, will point to the north if suspended so as to swing freely; therefore, to repeat in Fig. 2 the experiments of Fig. 1 it is necessary not only to place the wire *A* in a horizontal position, but also north and south, and then the needle *B* will be drawn into a position parallel with the wire by the magnetic attraction of the earth. In the experiments with Fig. 1 we did not change the connections between the ends of wire *A* and the wires coming from the generator, but in the experiments with Fig. 2 we will have to change them; therefore, we will suppose that one of the generator wires is marked "positive," and the other "negative." If the positive generator wire is connected with the lower end of *A* and the negative wire with the top, or arrow head end of *A*, then, as soon as the circuit is completed needle *B* will swing clockwise, to a position such as *C*, if it is suspended above the wire, but if placed under the wire it will swing in the opposite direction. If now the connections between wire *A* and the generator are reversed, so that the positive generator wire connects with the top of *A* and the negative generator with the bottom of *A*, we will find that as soon as the circuit is closed, the needle *B*, if suspended above the wire, will swing counter clockwise, and if placed under *A* it will swing clockwise. Thus we find that by reversing the direction of the current through the wire we have reversed the direction in which the needle swings. We have reversed the direction of the current through *A* in these experiments because we have reversed the connections with the generator, and the direction of the current through the generator must remain unchanged.

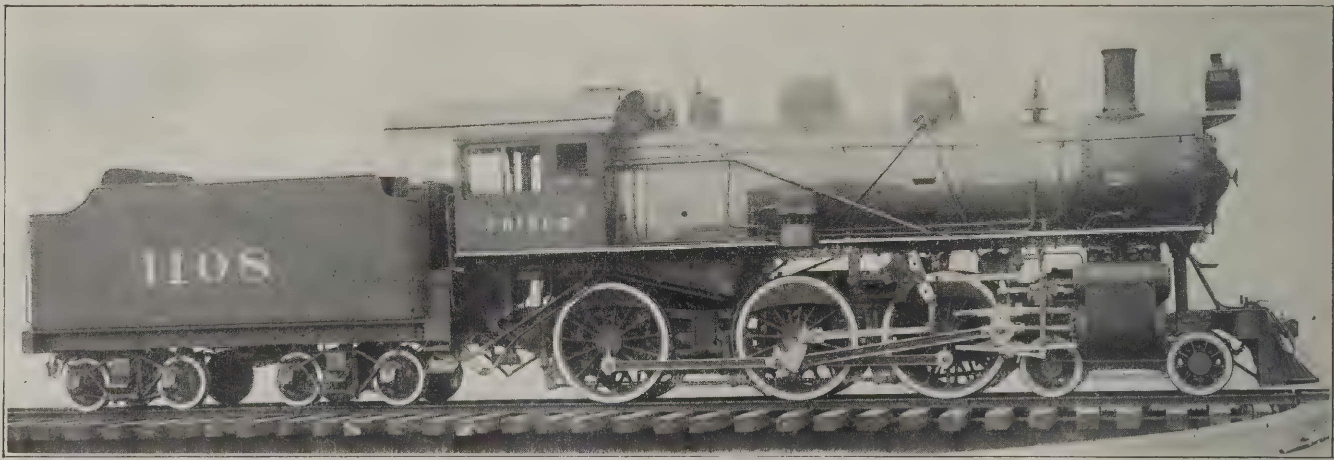
If we were to stand straddling wire *A*, with the needle in front of us, then if the current through the wire were flowing away from us, the needle if above the wire would swing clockwise, and if the current were coming through the wire toward us, the needle would swing counter clockwise. Thus we determine the direction of flow of the electric current by the direction in which it causes a magnetized needle to swing. This is merely an assumption that electricians have agreed to, but it is no proof that the current flows in such direction nor that it flows at all.

* * *

ST. LOUIS & SAN FRANCISCO TEN-WHEEL LOCOMOTIVES.

An order of ten ten-wheel locomotives has recently been completed at the Schenectady Works of the American Locomotive Company, for the St. Louis & San Francisco Railroad. These engines are duplicates of a previous order built for the "Frisco" system by the same company, except for the application of the Walschaerts valve gear, and are illustrated herewith as showing the latest and most simple arrangement of this gear of any employed on previous locomotives of this type built by this company.

The ten-wheel and Pacific type locomotives do not lend themselves as readily to a simple design of this gear as some of the other types with two-wheel trucks where the wheel arrangement permits of the link bracket being bolted to the back of the guide-yoke, and the position of the reverse shaft allows direct connection of the reverse shaft arm with the radius bar through a slip joint. In these engines, however, the design of the valve gear has been worked out to give as simple an arrangement as that used on some of the other types where the conditions are more favorable. The valve stem is connected to a crosshead which slides on a single bar guide supported at the front end by a knee bolted to the guide yoke. The combination lever is connected to this crosshead, the connection being below the radius bar. The link is carried in a bracket bolted to the front of a cast steel cross-tie located between the first and second pair of driving wheels. The reverse shaft is carried in a bearing at the back of this same cross-tie. This brings the reverse shaft in such a position as to permit of the direct connecting of the reverse shaft arm with the radius bar by means of a slip block and trunnion. Following are the principal data:



St. Louis & San Francisco Ten-wheel Locomotive.

General Specifications, St. Louis & San Francisco Ten-Wheeler.

Cylinder: Type, simple piston valve; diameter, 21 inches; stroke, 26 inches; piston rod diameter, 4 inches; piston packing, cast iron spring rings.

Valves: Type, piston; travel, 5¾ inches; steam lap, 1 1/16 inch.

Gage, 4 feet 8½ inches; wheel-base, driving, 15 feet 10 inches; rigid, 15 feet 10 inches; total, 26 feet 10 inches; total engine and tender, 55 feet ¾ inch.

Weight, in working order, 183,000 pounds; on drivers, 136,000 pounds; engine and tender, 310,800 pounds; tractive power, 28,300 pounds.

Axles, driving journals, main, 9 inches x 12 inches; others, 9 inches x 12 inches; engine truck journals, diameter 6 inches, length 11 inches; tender truck journals, diameter 5½ inches, length 10 inches.

Boiler, type, extended wagon top; outside diameter first ring, 66⅜ inches; working pressure, 200 pounds; fuel, soft coal.

Heating surface, tubes, 2,489.7 square feet; firebox, 164.6 square feet; total, 2,654.3 square feet.

Firebox, type, wide; length, 102⅛ inches; width, 67¼ inches.

Grate, area, 47.69 square feet; style, rocking.

Thickness of crown, ⅜ inch; tube, ½ inch; sides, ⅜ inch; back, ⅜ inch.

Water space, front, 4½ inches; sides, 4 inches; back, 4 inches.

Crown staying, radial.

Tubes, material, charcoal iron; number, 318; diameter, 2 inches; length, 15 feet ½ inch; gage, No. 11 B. W. G.

Exhaust pipe, single nozzle, 5, 5¼, and 5½ inches.

Smokestack, diameter, 15 and 17⅜ inches; top above rail, 15 feet 7 11/16 inches.

Brake, driver, New York; tender, New York; air signal, New York; pump, Duplex No. 2 right hand; reservoir, 18½ x 126 inches.

Tender, frame, 10-inch channel and plates; style, water bottom; capacity, 6,000 gallons; fuel capacity, 10 tons.

Wheels, driving, diameter outside tire 69 inches; centers, diameter 62 inches; material, main, cast steel; others, cast steel; engine truck, diameter 33 inches; kind, cast iron spoke center; tender truck, diameter 33 inches; kind, cast iron plate center.

THE BARNES' LOCOMOTIVE SKIMMER AND BLOW-OFF VALVE.

The accompanying cuts, Figs. 1 and 2, show the Barnes' blow-off valve and locomotive boiler skimmer which latter is suited to any style of steam boiler, but mostly adapted to locomotive boilers. It is the invention of Mr. J. B. Barnes,

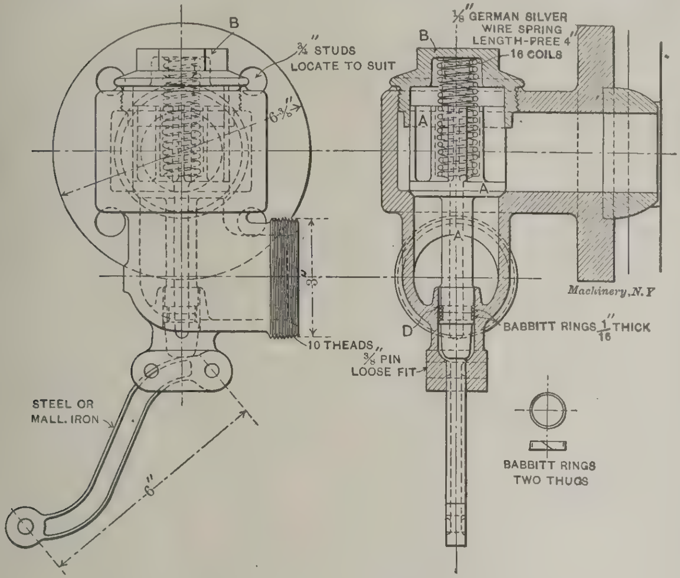


Fig. 1. Barnes' Blow-off Valve.

master mechanic of the Wabash R. R. with headquarters at Springfield, Ill. It is in successful use on that railway, and has been specified on a recent order for 110 new locomotives. The prime feature of this skimmer in connection with the blow-off valve is the prevention of foaming, the engineman being enabled at any time to blow off the contents of his boiler with the assurance that the blow-off valve will seat properly.

Referring to the cuts, Fig. 2 shows the skimmer applied to a locomotive boiler with the location of the blow-off valve indicated by dotted lines. The skimmer is designated at *A* and consists of two cast iron pieces bolted together at *B* and forming a U-shape, straddling the dry pipe and throttle-box stand. The skimmer consists essentially of a two-inch cast iron pipe with forty-four 5/16-inch cored holes, spaced equally on top. The top is made V-shape, forming a trough 4⅜ inches high and 6½ inches wide. The top of the skimmer is placed at the water level directly under the dome and embracing the dry pipe as stated. It is held securely in place by four hangers *C* attached to the roof of the boiler. On each side of the skimmer is a 2-inch outlet connected with the blow-off valve shown in Fig. 1, the connection being a 2-inch iron pipe with the necessary fittings that make it easy to apply.

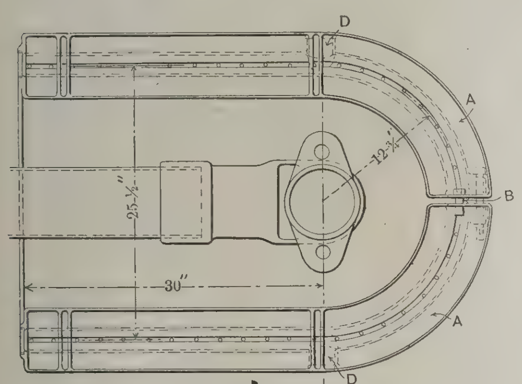
The blow-off valve, Fig. 1, is made of brass with the exception of the lever which is either of malleable iron or cast steel. The valve and valve stem are made integral, the part above the seat having four wings which fit into the projection of the nut, thus forming a guide for the upper part of the valve which, in connection with the babbitt ring guide for the stem proper, insures the alignment of the valve and proper seating at all times. A pocket is cored in the valve to receive a ⅛-inch German-silver wire spring 1 inch in diameter and 4 inches long. This spring forces the valve back to its seat whenever the lever is released. For convenience of operation a ½-inch iron rod is extended back from each blow-off valve to the cab, and handles are placed within easy reach of the engineer and fireman, who can readily relieve the foaming and priming, whenever necessary.

Barnes' Locomotive Skimmer and Blow-off Valve.

Statement of Atlantic type engine No. 615, 21 x 26-inch cylinders, equipped with Barnes' boiler skimmer, running in passenger service and using such feed water as found in Wabash River Valley, which is largely impregnated with sulphates and carbonates of lime and magnesia, and more or less chloride of sodium or salt. Time, October 26 to November 23, 1906, in pooled service:

	With Skimmer.	Without Skimmer.	Saving.	Saving in dollars and cents.
In service, miles	8,173	1,000	7,173	
Times washed (7 hours per washing)	1	8	7 at $1.50	$10.50
In service, hours (rental $15.00 per day or $0.625 per hour)	665	616	49 at $0.625	30.63
Fuel, pounds (1,000 pounds to one washing)	1,000	8,000	7,000 at $0.0685	4.80
Total				$45.93
Complete cost of device applied to locomotive				$35.00

Condition of boiler at end of test: 1½ inch mud in bottom of boiler; 8 inches mud in leg of fire box; crown-sheet in perfect condition.



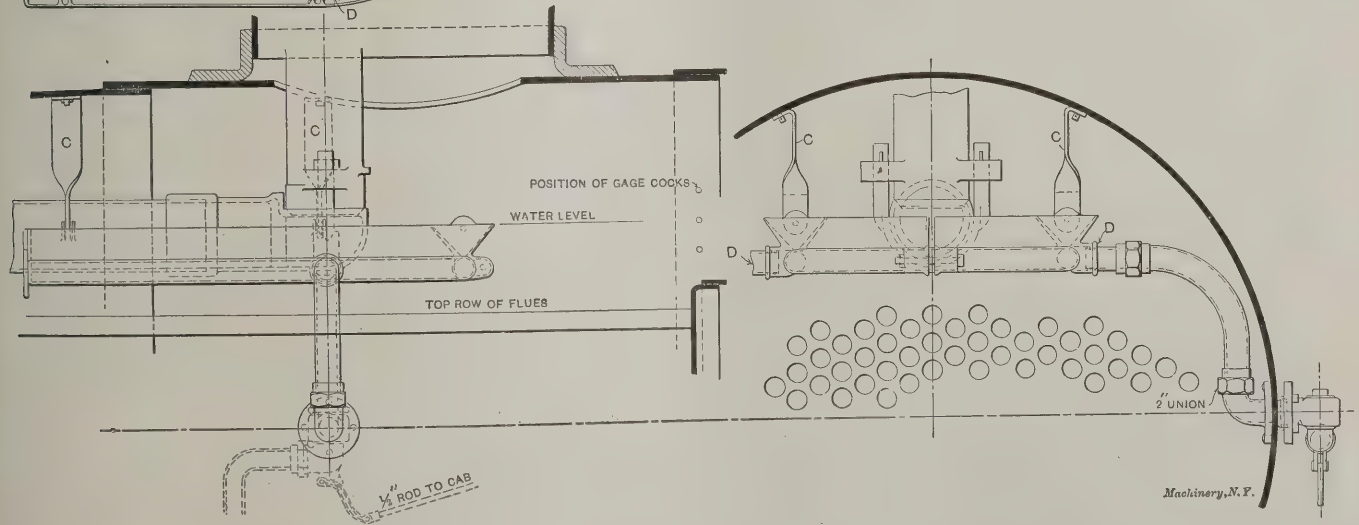


Fig. 2. Barnes' Locomotive Boiler Skimmer.

It is claimed that an engine equipped with these appliances and properly operated will make eight times as many miles between washings as other engines not so equipped. This being true, it is obvious that the saving of expense due to washing and to boiler repair incident to contraction and expansion in washing is very important and can scarcely be overestimated. This claim is apparently substantiated by the experience of the Wabash R. R., and a statement is supplied

by Mr. Barnes giving the record of engine No. 615, used in passenger service between Peru, Ind., and Detroit, Mich. The accompanying report is that of Mr. G. W. Smith, master mechanic of the Peru division.

* * *

THE ACTUAL EFFICIENCY OF A MODERN LOCOMOTIVE.—1.*

A COMPARISON WITH THE LIGHTER LOCOMOTIVES OF TWENTY YEARS AGO.

The comparisons between the locomotive of the present day and those built twenty years ago are to be based on:

1. The theoretical efficiencies.
2. The first cost.
3. The interest on the investment.
4. Depreciation in value.
5. Cost of fuel consumed.
6. Cost of supplies consumed.
7. Hauling capacity.
8. Cost per ton mile.
9. Reliability of service.
10. Time lost in shop repairs.

1. Theoretical Efficiency.

The comparison will be based on coal and water per horsepower per hour. Any marked saving in this direction is to be found only by comparing single expansion engines with compound engines, or with those using superheated steam. The water rate of single expansion engines has not been improved to any appreciable extent since 1885.

At that time consolidation engines with cylinders 20 x 24 inches were in use. They had Stephenson valve gears, which were as well designed as to-day. The boilers with their narrow fireboxes did not evaporate quite as much water per pound of coal as is done now with wide fireboxes and longer boiler tubes. The theoretical advantages of compounding are familiar to all, but the results of a recent comparative test on the Chicago and Eastern Illinois between two ten-wheel freight engines, one a four-cylinder balanced compound weighing 191,060 pounds, and the other a single expansion engine weighing 185,800 pounds, will be of interest.

The average of seven tests on each shows:

	Compound.	Single Expansion.
Water per horsepower per hour..	29.20	34.12

Saving by compound in per cent of water, 17 per cent.

There also should be incidental economies resulting from the use of the balanced compound engines, as they should be free from frame breakages and much easier on the machinery as well as the rail, due to the fact that the forces in these engines are perfectly balanced.

Superheated steam is comparatively new and still in the experimental state, but its advantages in reducing the water rate per horsepower are proven without question. The following results of tests made by the Canadian Pacific Railroad show what has been done in this line. The Schmidt fire-tube superheater was used:

	Coal per 1,000 ton miles. Pounds.	Saving by Superheat. Per cent.
January to May, with superheater...	129	26.70
Freight, without superheater.........	176	
June to September, with superheater..	382	22.83
Passenger, without superheater.......	495	

Feed-water heaters have been tried but are not used except experimentally as yet. Two items which must be considered when making comparisons of the quantity of coal burned on modern passenger trains are, first, the heating of the cars of the train by steam, and second, the electric light plant for the headlight and also for cars of the train, both of which are sources of very severe drain on the boiler, and only affect the modern locomotives. Twenty years ago cars were heated with stoves and lighted with oil or gas.

In some tests made by the Gold Car Heating & Lighting Company on the Northern Pacific Railroad in extreme cold weather, by catching the drips from the cars, it was found that sixty-two pounds of water per car per hour were obtained. Ordinarily the consumption of steam would not average over fifty pounds, so that if we assume ten pounds of coal burned on the engine per car per hour, in addition to the regular amount needed for moving the train, we will be on the safe side. With ten-car trains this would be 100 pounds per hour. Of course if there are leaks in the train-pipe, as sometimes occur, especially at the couplings, the amount will be increased.

Electric lighting of trains, whether the current is generated by a steam engine and dynamo in the baggage car, or whether the generators are driven by the axles of the cars, places an increased coal consumption upon the engine. The Northwestern Limited trains between Chicago and St. Paul were lighted by the former method, the current in use during the evening representing about 15 kilowatts, or 20 horsepower. If each car is lighted with 600 candlepower, there will be about 2,400 watts required, or, say, three horsepower per car, and this will represent in round numbers about 15 pounds of coal per car per hour.

Improvements in the valve-gear are continually being experimented upon but only two types need in this country to be given serious thought, the Stephenson link-motion and the Walschaerts valve-motion. The Stephenson link was in general use twenty years ago and is the most common to-day, but in the last year or two the Walschaerts gear has been applied to a great many new engines. No economy is claimed for this gear over the Stephenson, and its application is due to mechanical simplicity and reduced weight. No comparative tests have been made to my knowledge, so it may be assumed that no gain in the water rate is obtained.

2. First Cost.

In 1885 and 1905 engines were sold by the builders at the following prices, as shown in the following relative weights and prices of locomotives:

1885	Weights.	Price.	Price Per lb.
American	80,857	$6,695	0.0828
Mogul	72,800	6,662	0.0912
Ten-wheeler	85,000	7,583	0.0892
Consolidation	92,400	7,888	0.0854
1905	**Weights.**	**Price.**	**Price per lb.**
American	102,000	$9,410	0.092
Atlantic	187,200	15,750	0.083
Pacific	227,000	15,830	0.07
Ten-wheeler	156,000	15,690	0.088
Consolidation	192,460	14,500	0.075

The price per pound is figured from the total weight of the engine with three gages of water in the boiler, but excluding the tender.

3. Interest on Investment.

This figure is governed by the economic conditions of the country. At present the usual rate of interest is four per cent. In 1885 it was five to six per cent. Interest is therefore one to two per cent lower than in 1885. The fluctuation between the two dates has been great, especially during the panic of 1893 to 1897.

4. Depreciation in Value.

This division of the general subject allows considerable discussion. As soon as the engine goes into service, its value takes a sudden drop due to the fact that it then becomes a second-hand machine. After this its depreciation is gradual until the cost of repairs and maintenance equals the service which can be obtained for it. Under average conditions prevailing in this country this occurs after a service of about twenty years when the curve of depreciation runs parallel to the base line. It may be discussed systematically by dividing it into several principal headings.

1. The original cost of the locomotive and its present value. To the cost charged by the builder should be added the freight charge for delivery and the cost of breaking in the locomotive. The value of locomotives which have been in service a number of years, but which are in good working order, may be obtained approximately by obtaining the net weight of the locomotive proper, without tender, and without water in the boiler, and multiplying this weight by seven for the value of cents.

2. Depreciation must have some relation to the estimated life, but it is not necessarily a constant, as is often assumed.

* Abstract of paper read by Wm. Penn Evans before the Pacific Coast Railway Club, March 17, 1906.

The common rule is to divide the original cost by the estimated life in years to find the yearly depreciation. A more rational method is based on the fact that after certain periods of service locomotives depreciate more rapidly. When this is taken account of it is suggested that for the first five years the full second-hand value of the locomotive may be taken; for the second five years 85 per cent of this second-hand value; for the third five years 70 per cent; and after fifteen years 50 per cent of the second-hand value; after 20 years 25 per cent of the first cost.

Again the money invested in a locomotive may be treated as an amount of capital which is to be redeemed by an annuity in a certain period of years. For example, if the life of a locomotive is taken as fifteen years, and the interest at six per cent, we find in the annuity tables that the annual payment required to redeem $1,000 in fifteen years is approximately $43, and for a locomotive costing $10,000 the annual charge would be $430, which is considerably less than the straight charge obtained by dividing $10,000 by 15, which equals $666.

This argument applied to engines in 1885 as well as 1905, except concerning the length of life of the engine. The actual life of a locomotive is a very uncertain thing to compute. An engine thirty-eight years old was recently withdrawn from active service, having the original rods, frames, etc., and in England engines are said to be running in the neighborhood of fifty years old, and a Baldwin engine sixty years old is still in operation in Cuba.

Generally in this country when a locomotive is twenty years old it is supposed to have reached the limit beyond which it is not considered policy to spend much money for repairs, and if the same size and price of engine were purchased with which to replace it, an annual charge of five per cent would create sufficient funds to effect a renewal at the end of the twenty-year period.

From what has been said it is plain that depreciation depends more on the service and use of the locomotive than the locomotive itself. Since engines twenty years ago were used more carefully and made fewer miles in a month than they do now, the rate of depreciation was much lower than to-day. In this respect the charges against an engine of 1885 would be less than for an engine of 1905.

5. Fuel.

We were unable to get reliable data for the past twenty years, but to illustrate we will give such information as we have been able to gather for the years 1897 to 1905.

1897 coal cost us	$3.37
1898 coal cost us	3.20
1899 coal cost us	3.12
1900 coal cost us	3.12
1901 coal cost us	3.29
1902 coal cost us	3.14
1903 coal cost us	3.17
1904 coal cost us	3.26
1905 coal cost us	3.38

The introduction of oil has reduced the cost of this item on roads within reach of the oil supply.

An average figure for evaporation of water per pound of coal is 6¼ pounds. From the results of a number of tests made with fuel oil in California we may safely allow 10½ pounds water per pound of oil.

Assume coal, $3.38 per ton; oil, ¾ cent per gallon of 8 pounds; 168 gallons oil = 1 ton coal; then:

Coal at $3.38 a ton or 0.169c. per pound, $\frac{0.169}{6\frac{1}{4}} = 0.02704$ cent.

Oil at ¾ cent per gallon or 0.09375c. per pound, $\frac{0.09375}{10\frac{1}{2}} =$ 0.00892 cent.

When the boilers are equipped with some form of superheater the evaporative rate for both oil and coal is lower, but they continue to bear about the same ratio. This is due to the fact that some of the heat of the boiler is diverted from evaporating water to superheating the steam, and also because of the reduction of the heating surface effective for evaporating water. This is not true of the Vauclain superheater, which is entirely in the smoke-box and utilizes the waste gases for the purpose of superheating the steam without in any way reducing the heating surface of the boiler.

6. Supplies.

As fuel has been discussed separately, the item of "Supplies" will include water, oil, waste, and tools. Where water has been treated chemically to precipitate the scale forming salts, it has a real value after treatment, aside from the cost of putting it in the locomotive tenders, which varies greatly with the character of the water and the method of treatment. Twenty years ago water was not treated at all. To-day very few railroads use a water which they know is bad without treating it first. The money paid for water treatment is then an expense which is found charged to engines to-day which was not charged twenty years ago.

The cost of oil is a subject of a great discussion among motive power men, and although the cost of lubricating locomotives is usually not over one per cent of the locomotive expenses, it generally receives as much attention as the cost of fuel. When we consider that the fuel ordinarily runs into expense thirty or forty times as fast as oil, there seems to be little reason for this anomalous fact unless it is the peculiar conditions under which lubricants are purchased. Very often there is an agreement with the oil company that lubrication will be effected for a specified figure, and whatever is used over that amount (per engine mile) is supplied free of cost; that is, the extra cost as represented by the excess of oil used is refunded to the railroad when the annual settlement is made. At first sight this would seem to minimize the anxiety to make a good oil record, but the incentive lies in the fact that when the contract is renewed in one or two or five years' time, if the refunded amounts have been large the unit price is increased.

As an illustration: A certain railroad was working under a guaranteed amount of oil for locomotives at $1.20 per 1,000 engine miles. The year before the contracts expired, owing largely to an increase in the size of locomotives caused by the liberal purchases of heavy power, the cost (as charged out at the agreed prices) ran in the neighborhood of $2.00. While the amount necessary to reduce the cost during the life of the contract was promptly refunded, the price was raised in the new contract to $1.82 per 1,000 engine miles. These statements and documents passing constantly through the hands of the officials are no doubt responsible for the alertness with which oil consumption is watched, as no such arrangement obtained with fuel.

The following gives what may be considered a fair average of the number of engine miles for an engine to make on a pint of valve oil:

ENGINE MILES PER PINT OF VALVE OIL.

Engine.	Service.	Cylinder Diameter, Inches.	Miles Per Pint.
Simple	Passenger	17	150
Simple	Freight	17	100
Simple	Passenger	19	120
Simple	Freight	19	80
Simple	Passenger	22	90
Simple	Freight	22	60
Compound	Passenger	17 and 28	90
Compound	Freight	17 and 28	60

The above comparison shows that the modern engines can go only about one-half as far on a pint of valve oil as the smaller engines of twenty years ago.

The introduction of grease for heavy bearings of late years has made a saving which is shown in the following table:

ESTIMATED COST OF CYLINDER AND ENGINE OIL OR GREASE PER ONE THOUSAND MILES.

Engine.	Service.	Cylinder Diameter, Inches.	Without Grease.	With Grease.
Simple	Passenger	17	$1.31	$0.85
Simple	Freight	17	1.65	1.12
Simple	Passenger	19	1.67	1.08
Simple	Freight	19	2.07	1.41
Simple	Passenger	22	2.23	1.45
Simple	Freight	22	2.68	1.84
Compound	Passenger	17 and 28	2.23	1.45
Compound	Freight	17 and 28	2.68	1.84
			$16.52	$11.04

This shows a difference in totals of $5.48 and a saving of 33.2 per cent by the use of grease.

The cost of waste per thousand miles has been found to be proportional to the cost of the oil. From a report of the Chicago & Northwestern Railway, the cost varied on different

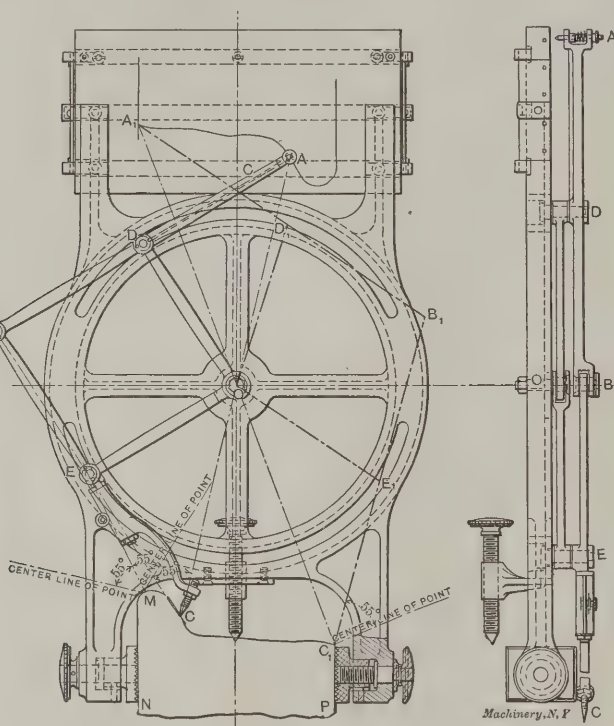
divisions from one-tenth to one-fourth that of oil, the average for the whole road being one-seventh, that is, where the oil costs $2.10 per 1,000 engine miles, the waste amounted only to 30 cents for the same distance. The oil and waste should ordinarily vary proportionately for engines of different size so that if we take the waste at one-seventh the cost of oil, we cannot be very far from the truth. If an engine is equipped for grease on all the main bearings the expense is much less, as then only the waste for the tender truck boxes and for wiping the engine is necessary.

* * *

TIRE-WEAR RECORDING GAGE.

CHARLES R. KING.

The gage here illustrated, designed and employed by the State Railways of France, records on paper the amount of tire-wear. The measure and registration of the tire-wear is



Tire-wear Recording Gage.

autographic, it being in fact an adaptation of the pantograph, tracing an inverted profile of the tire upon paper quadrilled to the millimeter, so that the most elaborate measures are at once visible to the eye without the use of rules. Consequently there is no subsequent need to transfer the measures to paper either in figures or graphically, as is necessary by the slow process attending the use of hand-gages, of which an example is to be found on page 441, May, 1906, issue.

The body of the instrument is of bronze, circular in form, with two downwardly projecting legs which embrace the tire and to which it is rigidly secured with adjusting screws and vise-like jaws. Above, at the top of the frame is a plate to which two hinged spring clips serve to hold the paper for the diagram. The pantograph proper is composed of equal-sized arms: $OD = OE = \frac{AB}{2} = \frac{BC}{2}$, and the point O being fixed, the guiding or tracing point C in describing any figure, causes the upper point A to describe a reversed homograph of equal size to the lever figure or model.

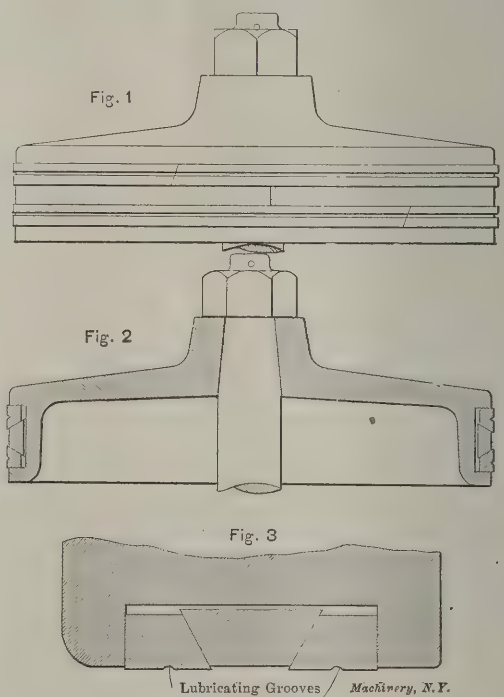
The weak point of pantographs is their want of rigidity. In this instrument the necessary rigidity of the articulated system is assured by the circular grooves in which the bearings D and E travel. The guiding point is of hardened steel and its leg carrier is pivoted on the rotating arm at E. The center line of the guiding point forms an angle of 55 degrees with the leg, and the point should coincide exactly with the center line of the leg, as shown in the sketch. A vertical screw at one side of the frame is used to set the instrument to the required height from the tread of the tire; and in setting the instrument it is indispensable that the point C (in the view at the right) shall pass through the plane corresponding exactly with the center of the axle which is assured by means of a straightedge. In operation the diagrams are obtained as follows:

From the outside corner of the tire at C_1 and the inner circumference of the tire at N, the arms of the instrument occupy the left-hand side of the gage as shown in the view. Guided by the figures the point is moved from C_1 to the upper corner of the tire flange at M, and there the leg is turned 180 degrees on its axis until the steel point occupies the reversed portion shown by the dotted center lines, when it is moved from M down the inside face of the tire to N. This leaves the outside face of the tire C_1 to P, still to gage. The pantograph arms are then pressed over to the right until they occupy the reversed position indicated by the dotted lines C_1, E_1, B_1, D_1, A_1, at the same time giving the guiding leg a half turn on its axis so that the point occupies the proper angle, shown by the dotted lines, for tracing the vertical line C_1 to P. The pencil which inscribes these movements on the paper is set in an adjustable holder provided with spring and screw so that it can be withdrawn backwards from the paper during any operations of setting the limbs of the instrument as just described. As a time-saving device in place of simple measuring gages, the instrument has an advantage, while the diagrams, when preserved, serve to show the relative wearing qualities of different makes of tires.

* * *

MARINE ENGINE PISTON PACKING.

An interesting form of piston packing was recently described in *Engineering*, which is made at the Craighton Engineering Works, Craighton, Glasgow; it is designed for use in steam engines, gas engines, pumps, air compressors, etc. It consists of three rings, the two outer rings being the packing rings proper, while the center ring is a tension ring. This ring has about double the amount of spring power possessed by the other two rings, and its construction is such that it does not touch the cylinder walls, its pressure being transmitted to the two side rings instead. The angle made by its



Three-ring Piston Packing.

side is such that the resultant side pressure tends to lock the bearing rings in the groove and thus produce a semi-solid piston. Hence it does not have the defect common to steam set packing rings of wearing the cylinder bore large at the ends when the steam pressure is greatest. The packing is made of a special cast-iron mixture for steam, etc., but when used for water pumps the rings are made of a special bronze. The packing is particularly recommended for superheated steam with high piston speeds, and it is claimed that it does away with the chattering that takes place with some other forms of rings. The construction is simple, being straight lathe work, with no hand fitting whatever required.

SPECIAL TOOLS FOR MUSICAL INSTRUMENT WORK.

S. J. PUTNAM.

The accompanying halftones show a patent guitar and mandolin head "machine" and special screw machine box-tools designed by the writer for the Hinzmann & Putnam Mfg. Co., New York City, during the period from 1898 until Mr. Hinzmann's death in 1904. The patented improvement on the open plate head machine, Figs. 4, 5, 6 and 7, consists of the combination whereby the wormwheel and stem *A*, Fig. 4, can be made in one piece instead of three, which means a saving of 192 parts in every dozen pairs of machines. The closed half plate machines, Figs. 1 and 8, and the closed whole plate machines, Figs. 2 and 3, although of unique design, are not patented. The Hindley form of worm *B*, Fig. 4, is used in order to have the full benefit of the difference in diameter of the stock and the diameter of the journals for a thrust bearing. When the diameter at the bottom of the thread is the same as that of the journal, and the thread is run straight across instead of on a radius, it will cut half of the throat collar away. Another point is the cost of cutting the thread. I suggested a box tool that could be used in a regular hand screw machine and would cut a Hindley worm of our required dimensions (7/32 inch in diameter, and 0.1 inch pitch) in record breaking time. However, we sent a sample screw to a well-known machine tool manufacturer to see what regular

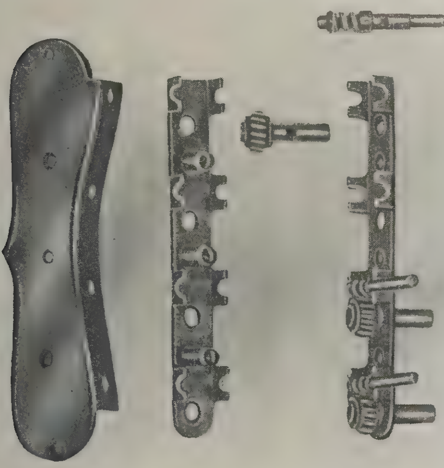
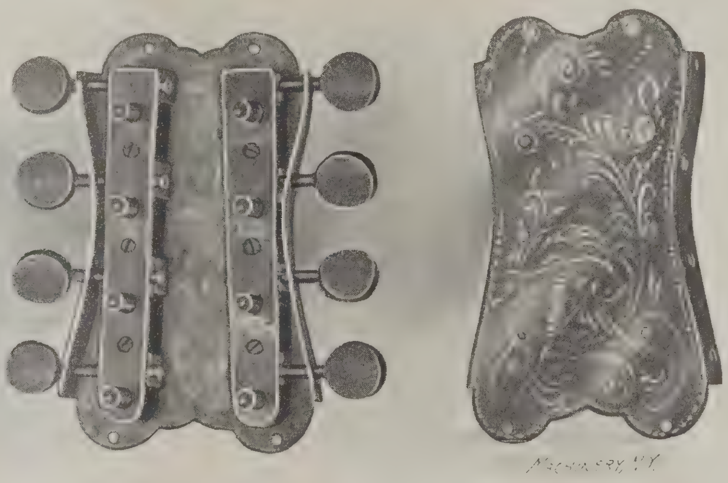


Fig. 1. Half-plate Mechanism Dismounted.



Figs. 2 and 3. Whole-plate Mechanism.

ways and means could do, and a screw machine with special leader-bar attachment was recommended for making it; an estimate was given that the machine would make 350 pieces (from rod brass) in ten hours. This did not look good to us, so the box tool shown in Fig. 10, which will be described later, was made instead.

Referring again to the wormwheel details: Other makes have a square hole through them and the end of the stem is milled square to suit; a hole is drilled and tapped in the end of the stem which passes through the plate, and a screw with a head large enough to cover the square hole in the wormwheel is used to pull the wheel down against the plate. The stem of our wormwheel *A*, Fig. 4, has a groove flush with the shoulder of the wormwheel. The width of the groove is made to correspond with the thickness of the plate *D*, Figs. 4 and 5, and the diameter at the bottom of the groove takes its bearing in the elongated slots shown at *E* in the plates Figs. 4 and 5. One end of the slot is made large to allow the barrel or stem of the wormwheel to pass in when assembling. The lugs *C C* which form the bearings for the worm are assembled on the worm and riveted to the plate through square holes at *F F*, Figs. 4 and 5, thus preventing the wormwheel from getting away from the end of its slot bearing. The metal for plates *D*, Figs. 4 and 5, is ordered in long strips and the fancy crown-shaped ends on plate *D*, Fig. 5, are made by a punch and die when cutting it up to the required length. All of the holes in the plate are made by a piercing punch and die in one operation.

A Brass Wormwheel and the Way it was Made.

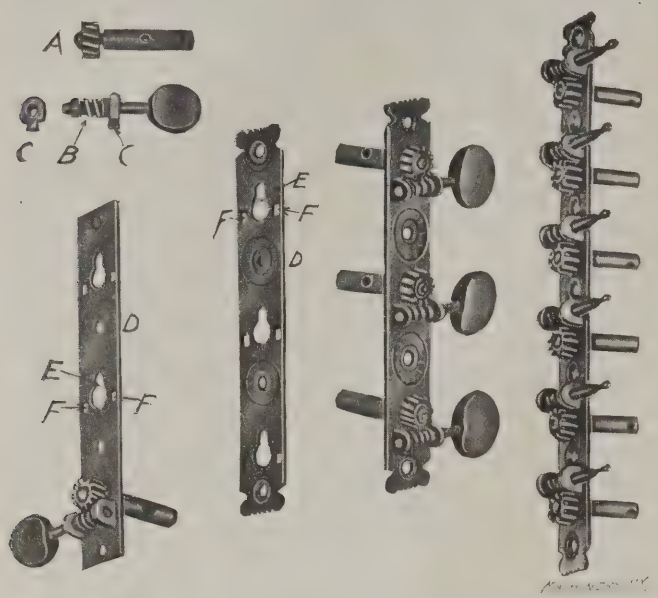
When we first started, all the metal parts were made of brass and the wormwheels were hobbed; the hob used was over 3 inches in diameter, 2.6 inches lead, 0.1 pitch (26 multiple threads), which made our wormwheel (which was 13/32 inch diameter with 12 teeth) resemble a spiral gear. This fact was an advantage when assembling, for the lugs carrying the worm could go straight down to the shoulder and be riveted without difficulty. Another reason for using a large hob was that we would need it in making the cutter to be used in the box tool for cutting Hindley worm threads.

In order to cut this 2.6 inches lead thread on our lathe, we compounded the gears by making a special gear for the inside end of the change gear spindle that would mesh with the gear on the cone pulley, and so on through the back gear quill to the gear on the main spindle. This main spindle gear had 78 teeth, and thus we got 26 multiple threads by removing an intermediate gear after cutting one thread and then turning the spindle a distance of 3 teeth on this main spindle gear, which gave the correct indexing for the next thread. The flutes in the hob were narrow and close together so that there would always be at least two rows of teeth cutting. The hob when finished was mounted upon a vertical shaft, and a spiral gear of the same diameter and pitch as the hob was fastened to the same shaft just above the hob. Tangent to this spiral gear and in mesh with its teeth was a horizontal shaft with a 12-tooth spiral gear, this being the number of teeth wanted in the wormwheel to be hobbed. It was only necessary to construct a frame that would swing upon this shaft as a center and having another shaft parallel with it and opposite the hob, each of the parallel shafts having a spur gear connected by an intermediate gear. The last shaft had a hole bored in one end the size of the stem of the wormwheel blank. Across this shell end of the shaft a slot was milled to drive the work wheel by means of a slightly tapered pin which was thrust into the hole used for fastening the strings of the instrument through the stem of the wormwheel. The stem of the wormwheel to be cut is slipped into the holder while the machine is running, and a hardened steel forked plate latch, pivoted on the side of the swinging frame, drops into the slot of the wormwheel stem, when a cam lever carries it and the swinging frame in until it reaches a stop. The wormwheel teeth are therefore cut with the wheel running in its own bearing. The cam lever is now released, which allows the frame carrying the finished wormwheel to swing away from the hob; the latch is then raised and the wormwheel drops out into the pan.

A Turret Tool for Knurling the Teeth of Steel Wormwheels.

The rig described worked well on brass and it was used for more than a year. We would have used it longer only for the good reason that we no longer made the wormwheels of brass. It was in the year 1899 and brass came high. The proposition of making all parts of steel then presented itself and was adopted, using nickel flat finish. The wormwheel

was superseded by a spiral steel gear, the teeth of which were knurled in the screw machine before cutting the piece off the rod. The turret tool shown in Fig. 9 accomplished this part of the operation in a very satisfactory manner. The body G has a stem H which is fitted to the hole in the turret. The jaws I, J and K have shafts through their entire length with hardened and tempered spiral gears keyed to the



Figs. 4, 5, 6 and 7. Construction and Details of Improved Instrument "Machine."

front ends, and also a set of straight cut gears of the same pitch and diameter at the other end. The straight cut gears are in mesh with a central pinion with twelve teeth and of the same diameter as the spiral gear to be "knurled." The meshing of this pinion and the straight-cut gears prevents the spiral gears from getting out of time. The jaws are fitted to slots in the body G, and, with pins L to swing upon, are given enough movement to allow the spiral gear "knurls" to pass over the blank to be cut.

The jaws are held open by open coil springs supported by U-shaped frames which rest on body G and have studs passing through them into the jaws as at M. The knurls are forced into the work by the clamp screw N and the depth of cut is regulated by the check nuts O O which stop against the band clamp P. While knurling, a stream of oil passes through the tube Q to the knurls. We have used both hot and cold rolled steel for these wheels with no difficulty from the teeth

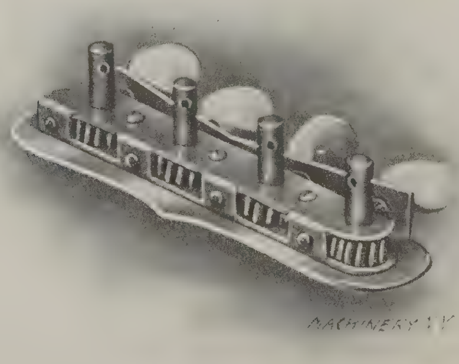


Fig. 8. Half-plate Machine Assembled.

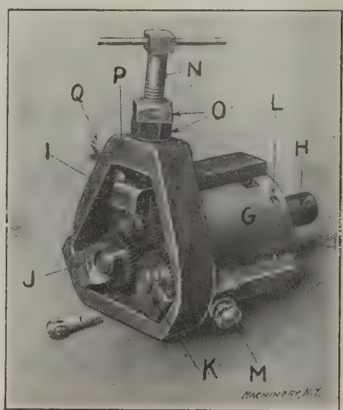
breaking. The tool that formed the blank is run in again after the knurling is done to trim up the ends of the teeth, after which the piece is cut off the rod.

Cutting a Hindley Form Worm in the Turret Lathe.

The tool shown in Fig. 10 is used for threading the Hindley worm. The cutting of the thread is the first operation on the blank rod. The cutting tool is an endless chaser revolving in front of the screw; it is fed straight into the side of the stock and the instant the required depth is reached the worm thread is finished. The tooth contact attained, although considered good for the purpose for which these machines are used, is less than that of an ordinary worm and wormwheel. The chaser tool, which might be called a hob, has twenty teeth, and the worm would therefore only be a Hindley worm when used with a wormwheel of twenty teeth, whereas we put it with a spiral gear of twenty teeth. This is done in order to reduce to a minimum the liability of waste in time when assembling. This is very essential, as the greatest demand for these machines is from manufacturers of the cheapest grade of instruments, and to this class of buyers competition has brought prices down to a surprisingly low figure.

The box tool is held in the turret by the stem R, and in the front end of this stem there is a hardened 60-degree center which forms a thrust bearing for the worm shaft S. This shaft has another bearing in the block at T, and a driving head is pinned to the front end, a detail of which is shown in Fig. 11. The distance from the point of one tooth in this driving head to the point of the tooth opposite is about 0.020 inch less than the diameter of the stock from which the screw is made. The teeth of the driving head work as an external broach when shoved on the edge of the rod, and it does not matter whether the blank is at rest or revolving, the grooves are always cut straight and parallel. When we were making the screws from brass rod the machine was run at 2,200 revolutions per minute, and was not stopped nor reversed.

The worm of the driving shaft is of the same diameter and pitch as the thread to be cut and is in mesh with a twenty-tooth wormwheel, which is a part of the sleeve and first gear U of the train of gears to the cutter arbor V. The sleeve runs on a post which is driven into the body of the box tool and extends through on the under side for the lower bearing of the swinging frame W. The block containing the adjust-



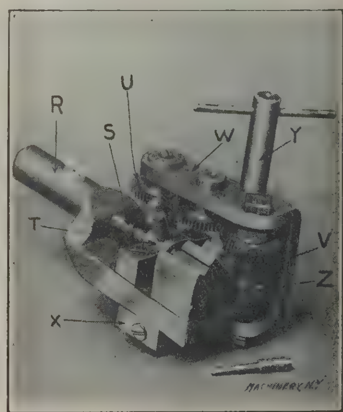


Fig. 9 Turret Tool for Wormwheel. Fig. 10. Turret Tool for Worm.

able stop screw X for depth of cut also supports the downward thrust of the cut on the front end of the swinging frame. The shaft Y, with handle, has two eccentrics which operate against the swinging frame on the upper and lower sides. This shaft has a long bearing in a boss on the side of the body of the box tool and the swinging frame is held against it by a spring so that after the cut is made, the frame is released automatically. The cutter arbor runs on adjustable screw centers and the top face of the cutter Z is set flush to a radial line of the work. Opposite the cutter is a steady rest fastened to a block on the body of the box tool.

Comparative Costs of Steel and Brass Worms.

While making the worm screws of brass, the average number of pieces produced per ten-hour day was 1,500 and the greatest number in one day was 1,700. When making the worm screws of steel the average number of pieces produced in ten hours has been 950, and the greatest number in one day has been as high as 1,100. When steel is 3¾ cents per pound and brass rod 14 cents per pound there is not much choice from a financial point of view which metal to use, but when the price of brass rod goes up to say 18½ cents there would be a difference of 7 cents per hundred in favor of using steel. In arriving at this conclusion I am charging 15 cents per hour against the screw machine man's time for his share of the company's running expenses. This amount will of course vary in different departments, or in the

same department at different times, according to the number of men required to do the business on hand. That is to say that the running expenses in the line of non-producers' salaries (from the president of the company down) power supplies, interest on investment, advertising, etc., will not vary much. We will say for example that in the department where these worm screws are made there are seventy-five workmen (not including foreman, draftsman, clerks, floor boy, or any other of the so-called non-producers). It will be seen from this that the department is charged with $11.25 per hour for its share of the running expenses of the company. In case it was found necessary to increase the number of workmen to one hundred the charge per hour against each man in order to cover this amount would only be 11¼ cents, whereas if the

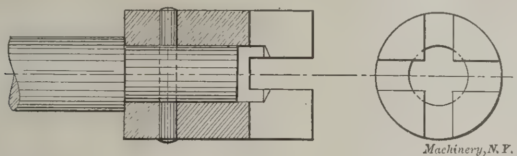


Fig. 11. Drive for the Mechanism of the Tool shown in Fig. 10.

force should be cut down to fifty on account of business being dull, the price per hour would come up to 22½ cents. Whether this system of figuring cost prices is very extensively used or not, I cannot say, but it is by no means new, however. In order to get down to facts for aid in the choice of material, a few figures of comparison may be interesting.

Actual cost of 1,000 worm screws of brass, the net price being 14 cents per pound:

Material, 15½ pounds rod brass at 14 cents........	$2.17	
Credit 1¼ pound scrap (chips) at 8 cents.........	.10	
		$2.07
Screw machine operation, piece work at 15 cents per 100		1.50
Charge for running expense 6.6 hours at 15 cents...		.99
Total of actual cost per 1,000 pieces................		$4.56

Actual cost of 1,000 worm screws of steel, the net price of material being 3¾ cents per pound:

Material, 15½ pounds steel wire at 3¾ cents......	.58
Screw machine operation, piece work at 24 cents per 100	2.40
Charge for running expenses 10½ hours at 15 cents	1.58
	$4.56

Actual cost of 1,000 worm screws of brass, the net price being 18½ cents per pound:

Material, 15½ pounds rod brass at 18½ cents......	2.87	
Credit 1¼ pound scrap (chips) at 8 cents.......	.10	
		2.77
Screw machine operation piece work at 15 cents per 100		1.50
Charge for running expenses 6.6 hours at 15 cents.		.99
Total of actual cost per 100 pieces................		$5.26

* * *

In connection with a number of boiler explosions which have taken place lately, some of these, particularly the one at the Lake Shore Collingwood shops, having resulted in fatal accidents, it has been pointed out that in some cases where boiler plate has been condemned by the United States inspection department for use by the government, it has nevertheless been used for boilers sold to private factories. For this reason it is urged that there should be adopted a general law for testing of boiler plate. Such a law would no doubt have good reasons for being passed, particularly if it be true that condemned plate is used to supply customers who are not in a position to themselves test the material in the boilers sold to them.

* * *

During the investigation in regard to the terrible Terra Cotta disaster on the Baltimore & Ohio Railroad, E. W. Kelly, Jr., trainmaster of the B. & O. at Baltimore, when questioned in regard to the hours of employment of men engaged in the handling of trains, stated that local train crews worked during October and November last on an average 16 hours a day for six days a week without a period of rest. In some cases trainmen worked 36 hours without relief, while others worked five and six days at a time on an average of 20 hours per day.

HELPFUL HINTS FOR THE TOOLMAKER.

F. E. SHAILOR.

The old saying that "one never learns the machinist's trade" tempts the writer to set forth a few kinks that will be of benefit to those who have not passed many years in the hard school of experience. The methods as set forth herein are in vogue in the finest toolrooms in this country, in watch factories, and in the manufacture of delicate measuring instruments. The reader may accept them for what they are worth.

Cutting a Smooth Thread.

When cutting threads, one often meets with difficulty in obtaining a smooth thread, such as is required for screw gages and taps. One good way to obtain a smooth thread is to turn the tap nearly to size and harden it; then draw the temper to a "light blue." When turning to size, if the tool does not stand up well, draw still lower, the object being to leave just enough temper in the tap to make the steel firm. By making light chips with a hard thread tool a glossy, smooth thread will result.

Another advantage gained by hardening the tap before finishing is that it will greatly eliminate the chances of the lead changing after the final hardening. A thin lubricant of lard oil and turpentine is an excellent one for thread cutting. When cutting two or more taps it is customary in some shops to rough out both or all the taps, leaving the dogs on them, and for sizing or finishing cut the taps are chased without moving the thread tool. But if the thread tool dulls a trifle

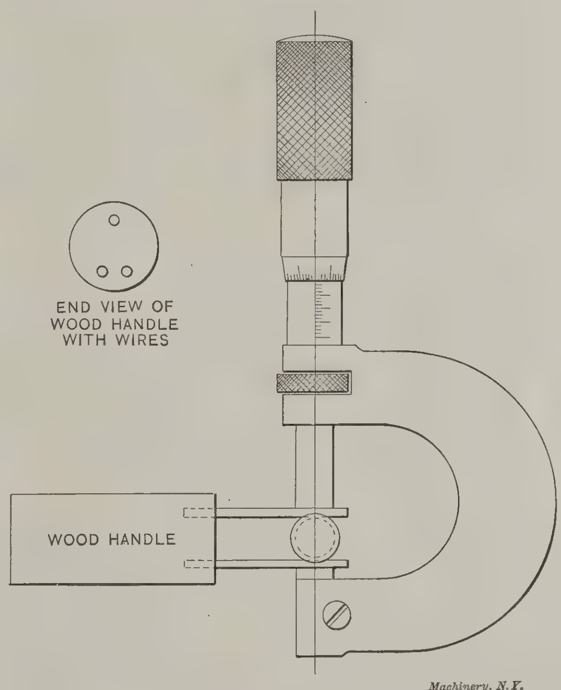


Fig. 1. Holder for Wires when Measuring Taps by the Three-wire System.

when making the finishing cut on first tap, the succeeding taps will not be exactly the same size. A good way to make a number of taps all of one size is to use a tool as shown in Fig. 1. Three fingers of small music wire are fastened in a handle. By placing the wires in the threads on the tap, as shown, and measuring with micrometers over all the wires, the taps to be made can be cut to exactly the same size, using same wires for measuring. If a solid thread tool is used, the cutting point should not project any further than is necessary from the toolpost, which will greatly reduce springing, which is one cause of rough threads, due to tool "digging" in. A curved neck thread tool gives best results, as this style of tool will spring away from the work instead of in.

A Kink on Hardening.

What will greatly reduce the chances of springing in hardening of an irregularly shaped punch or die is to thoroughly anneal same after it has been machined nearly to size. This will, of course, not entirely remove chances for accidents, as the prime cause of cracks and distortion of work is to be found in the operator's way of handling the piece to be hard-

ened. An illustration of what takes place when hardening may be given by referring to the die shown in Fig. 2. If we place the die in fire the points *C* will heat and expand quicker than the main body of the die and there must be a sort of a "pushing" effect between the points *C* and main body of die. For this reason we heat "slowly and evenly." Now, when we dip the die in the bath the points *C* immediately become chilled, and, of course, contract while the main body is still red hot. Assuming that the points have become entirely cooled, there must be a line that separates the part that has been cooled off from the red-hot part. It must follow that when the main body begins to contract there is a powerful strain at the line that separates the parts contracting at different times. For this reason the die should be removed when quite warm; this allows the heat to run out into the points and the contraction will be more even. If allowed to cool in the bath there is apt to be a crack at *D*. Polish the die to draw the temper, and do not depend on getting an even temper by drawing the die when it is dirty, as one part may draw faster than another.

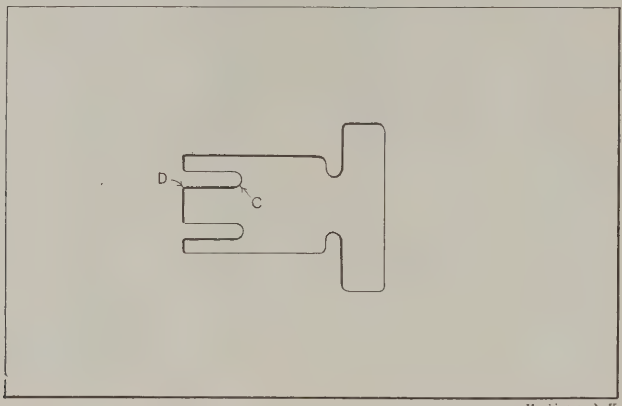


Fig. 2. Die of Irregular Shape subjected to Heavy Strains in Hardening.

Doweling Hardened Parts.

When making pieces such as sections of a built-up die, or any piece having dowel holes, it invariably happens that the dowel holes do not line up after hardening. One way to overcome this trouble is to tap the dowel holes a trifle larger than the dowels to be used, and after the piece is hardened, screw in soft plugs and file off flush with the work; when the piece is screwed in its proper place the dowel holes are drilled and reamed through the soft screw bushings. This will save a great deal of unsatisfactory lapping.

Simple Method for Cutting Cams Accurately.

Cams are generally laid out with dividers, machined and filed to the line. But for a cam that must advance a certain number of thousandths per revolution of spindle this divider method is not accurate. Cams are easily and accurately made in the following manner. For illustration, let us make the heart cam Fig. 3. The throw of this cam is 1.01 inch. Now, by setting the index on the miller to cut 200 teeth and also dividing 1.01 inch by 100 we find that we have 0.011 inch to recede from the cam center for each cut across the cam. Placing the cam securely on an arbor, and the latter between the centers of the milling machine and using a convex cutter, set the proper distance from the center of the arbor, we make the first cut across the cam. Then, by lowering the milling machine knee 0.011 inch and turning the index pin the proper number of holes on the index plate, we take the next cut and so on. Each cut should be marked on paper so that there will be no mistake as to number of cuts taken; when 100 cuts have been made the knee must be raised in order to complete the opposite side of the cam.

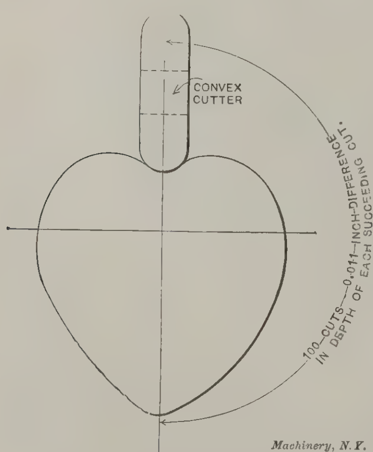


Fig. 3. Method of Cutting Cams.

Method of Locating Stock in Dies.

When a job will not warrant the expense of a sub-die the device shown in Fig. 4 will help wonderfully toward producing accurate punchings. To simplify the explanation, the die shown is to cut washers, the holes being eccentric with the outside. The die is laid out same as any double die, but the stop pin *G* is added, and as will be noted, the extension *K* does not come out of the die. If, however, one depends entirely on this stop pin, the result will not be satisfactory, because when the stock is pulled against the stop pin the web between the blanked places will bend a trifle, especially if the stock is thin. Therefore the long pins *H* are added, and as these long pilots or traveling dowels are well pointed, and are considerably longer than the punches, they of course enter the holes and force the stock back to its proper location. The pilots fit the holes in the die and they therefore act as dowels while the punch is cutting. The pilots and the spring butts *L* keep the stock pressed firmly against the gage side of the stripper, and the stock can vary 1-16 inch. With this construction the operator is enabled to keep the press running constantly to the end of the strip. At each stroke the punch *G* cuts out the web and allows the stock to slide along to the next web and there is absolutely no possibility of the stock jumping the stop.

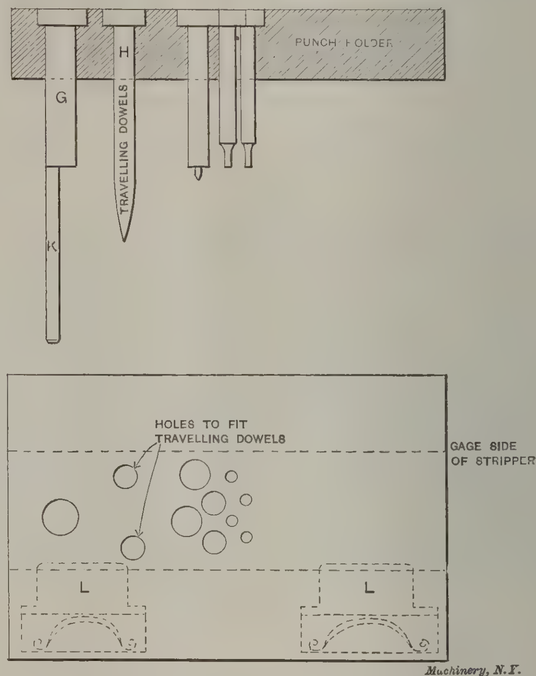


Fig. 4. Punch and Die with Guide Pins.

As washer or small wheel dies are generally made to cut four or more blanks at one stroke, the following method of transferring the holes to stripper and punch holder will be of benefit to some readers. If the punches are small it is advisable to make the stripper, say, ½ inch thick, and dowel it with four good-sized pins to the die. The holes through the stripper are bored to fit the punches nicely. This will act as a guide and prevents the punches from shearing. When the stripper is doweled to the die we lay out the former with buttons or by other methods governed by accuracy demanded and each hole in turn is indicated, and bored through the stripper and die. If the holes are so small that they will not readily admit boring to such length, the stripper may be bored and removed and the die then bored. The die must, of course, be fastened in such a manner that the stripper can be removed without loosening the die. If properly doweled the punch holder, stripper and die can be bored together, thus insuring perfect alignment of the punches and the die.

A Good Way to Make an Irregular-shaped Die.

Fig. 5 shows a time saver, as the die can be made easier and better because the parts can be ground to size instead of the die being filed out. Another advantage is that if the

pieces warp in hardening they can be ground into shape again. The pieces *M* are shrunk on the sections, holding them securely together. The holes *N* are drilled for clearance for the emery wheel when grinding to size. The straps *M* are made a trifle shorter than the die over all, say 1-16 inch to the foot, and are heated red hot in the middle and placed in position while hot and rapidly chilled. After the pieces are shrunk on, the dowels are transferred into the bolster.

Another good kink when making irregular-shaped punches that are to cut thin stock is to make them of machine steel and caseharden them. Soft steel, casehardened, does not change its form as much as tool steel, and even if the punch does change a trifle the interior is soft and can be readily forced back to position. The outside being hard, the punch will wear nearly as long as one made from tool steel, for practically the only wear on a punch is when passing through the stock. For thin brass the punch works well when made of tool steel and left soft, and when worn badly the punch can be peened on the face enough to upset and then sheared into

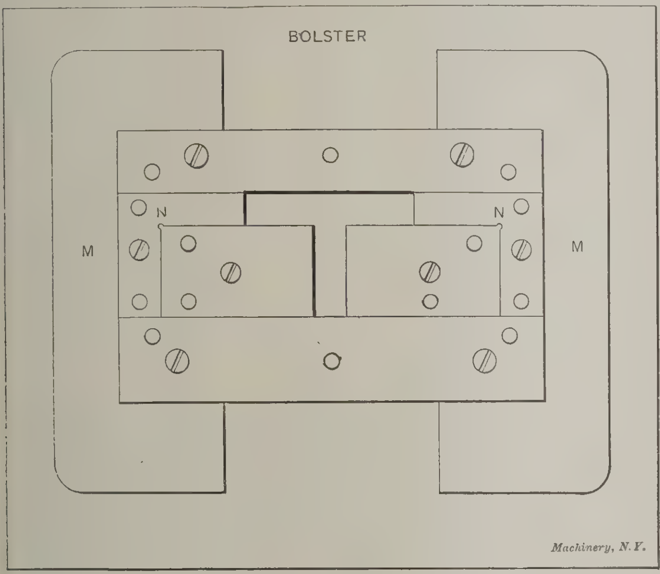


Fig. 5. Example of Built-up Die.

die. When cutting a heavy blank it is a good plan to grind the die so that the surface is quite rough as the high spots then cut a trifle ahead of the low points. This will cause the die to run longer between grindings and is also easier on the press, while with a die that is ground perfectly smooth the entire cutting surfaces of punch and die meet simultaneously and the entire cutting surface of punch and die are placed under a tremendous strain. By grinding the die slightly lower on each end, thus producing a shearing cut, the die will last longer.

* * *

There has of late been some experimenting in the machine tool line to introduce leather clutches in place of the tooth clutches which always are more or less objectionable on account of the noise which is practically inseparable from their use. In automobile design the leather clutches have also gained more or less prominence. For this reason it is of interest to note some rules given in the *Autocar* for treating clutch leather. The most difficult trouble with leather clutches is that the leather after a time becomes too smooth and hard, obtaining practically a polished surface. In such cases it is necessary to dismount the clutch and scrape the polished surface of the leather with a knife or a coarse file and then immerse the clutch in water of a temperature of 80 degrees F. until the leather is thoroughly saturated. To attain this will take about 24 hours. The leather should then be dressed with oil, liberally applied, and as the water dries out, the oil will soak in and replace it. This will prevent the surface of the leather from getting hard, and showing a polished appearance, which, of course, is greatly detrimental to the power transmission qualities of the clutch.

* * *

If one-half of six be one-eighth of three what would one-third of a quarter be?

THE APPRENTICE AND HIS BEST GIRL.

E. R. PLAISTED.

Much has been written of late on the apprentice question, and as to why so many boys fight shy of the machine shop, and so many young men leave it for other occupations. Among the reasons for this the influence of wives and sweethearts has been mentioned as not being the least effective. There is no denying that the men and women we come in contact with have much influence over us and much effect upon our lives, no matter how independent of thought and action we may be. In the case of a young fellow just deciding on his course in life this is especially true, and if there is anything about the machinist trade that works against him in his standing in society, or with his wife or sweetheart, it should be remedied if possible.

"It is not good for man to be alone," and while that society which can only be adequately spelled with a very big S is not likely to enter much into the problems of a man who must earn his living at any trade, or whose purposes in life are vital and actual, the companionship of educated and cultured people is a thing to be prized and sought by anyone. It is not enough to have merely avoided bad company, for the man who shuts himself up in his shell too closely never reaches the best he is capable of, no matter how absorbing and engrossing his work may be.

The old saw about all work and no play applies to us at all ages and in all walks of life. Under normal conditions and circumstances there are very few times in our lives when we cannot to advantage indulge occasionally in play of some sort, and then we are pretty sure to crave the companionship and society of our fellows. Even the lower animals congregate together for sport and frolic.

Conditions which are the growth of recent years and which have changed and modified our whole social structure have, naturally, had their effect on the social standing of the workingman, but I do not believe the time has come yet, or that it is likely to, when a man will fail to win deserved recognition from those whose companionship will be valuable to him, just because he is a "dirty machinist."

I wish those boys who take up with counterjumping and other poorly paid but "genteel" occupations could realize that a machinist is not necessarily dirty, even while at work, and that a really good workman—no matter what his trade, usually takes some pride in himself as well as in his work. I know a case of two machinists that well illustrates how much depends on the man and how little on his occupation in such matters. Nearly all the conditions under which they work are practically equal, and both are men of skill and experience. One of them gets just about as many dirty jobs, real soft squashy snaps, as the other, but while one wears a neat tie and linen collar and keeps them presentable the week through, and in general has a clean appearance, the other has such a faculty for attracting to himself the dirt and grime that often by ten o'clock of a Monday morning it might well puzzle a stranger to tell whether he is of African or Aryan ancestry. The machinery business is not to blame for such a state of affairs.

Of course there is considerable difference in shops as to the standards of cleanliness and the encouragement offered a fellow to keep himself respectable in appearance and habits, but shops are not common where a premium is put upon vileness of language or person, or where a young fellow who tries to keep himself wholesome will be persecuted therefor. I did once know a foreman who said no man could work for him and wear a boiled shirt in the shop, but the kind of boys I'm talking about wouldn't work for that sort of a man long, anyhow if they knew it. If you find yourself in a shop where these influences are not only neutral but actually negative, better get out; it is no place to grow and get ahead.

I doubt if there is now much cause to complain about the average shop in this respect, though there is probably plenty of chance for improvement; for while the foreman may have done all we can reasonably require of him when he provides well swept floors, well washed windows, and decently clean and sanitary toilet accommodations, still no one can do so much as he to establish a sort of cleanly atmosphere in which a dirty man will feel himself out of place. It is claimed now-

a-days that health is contagious as well as disease. Isn't it quite as likely that cleanliness may become "catching" in a favorable environment?

It may be true that the apprentice sometimes finds his best girl sitting in the hammock with the bank clerk or the dry-goods clerk whose hands are nice and white and whose tailor-made clothes take the bulk of his income; and it may be true that the influence of wives and sweethearts has caused good men to give up the shop for some more cleanly place. All this may be true, but I have enough faith in both wives and sweethearts to believe that, to the majority of them, the man who attracts and holds their respect and affection is the man who *does things*, things worth the doing, and who does them well.

The girl who throws over the machinist or the apprentice for a clerk probably made mud pies when she was younger, and enjoyed it fully as much as did the girl the machinist finally does marry. There is a time in the life of most normal boys when they have a mighty dread of soap and water in combination, though they know the water is all right to go swimming in, and the soap a most excellent thing to secrete inside the apple the other fellow brought for his luncheon. But your girl grows out of mud-pie pleasures, and your boy—if home influences are what they should be—usually gets over his fear of soap and water fully as soon as he gets over being afraid of the girls.

We all love the girls who are sweet and neat, it is the natural and rightful heritage of maidenhood, but the girl who is merely "finicky" and declines to sit in the same hammock with a promising young machinist just because there is a little honest dirt ground into his palms too deeply for soap to remove, that girl is not necessarily wholesome at heart and will very likely make anything but a helpful wife for either the machinist or the clerk.

Entropy says his neighbors across the way may think what they please and he will not budge a hair, but admits he values the opinion of some other "neighbors" whose very place of residence is unknown to him. Most of us come to this view sooner or later, but we can't quite expect it of the young apprentice. The girl across the street is a heap more real and interesting to him than the shadowy image we call the average girl. It is the particular girl he is interested in, not the average girl, and he will fight shy of the shop if he thinks working there will place him at a disadvantage in her eyes and favor.

I admit it is puzzling to me why society should draw the line at some kinds of dirt and disorder and yet put up with others far more disagreeable and annoying. For instance: why should the ban be put upon a little innocuous cast-iron dust and smiling toleration be accorded a breath that would stop an automobile, or a voice that would file a saw? These last abominations are not uncommon, even in the big S society. Perhaps it is for the same reason that two standards of morality have been set up, one for men and the other for women, if anybody can tell what that reason may be. Anyhow it is beyond me, but the men and women whose companionship is a thing to be prized and sought and deserved do not often make either of these glaringly inconsistent and unjust discriminations.

We are all looking for things that "pay," and it pays big to have the advantages given by a wholesome and attractive personality; to be physically clean inside and out. The dirty hands yield to soap and water and energy, and the foul breath generally succumbs to physic and water and determination. None of these have yet been cornered by the clerks, and when the young machinist has made liberal use of them, the people he ought to know, will, if he gives them a fair chance, find him out and take him for all he is honestly worth. If he has the qualities that appeal to men and women of the better sort they will hardly hold him at arm's length because of his occupation.

The root of some of these troubles lies in a trait that is said to be growing national with us, our lazy way of submitting to petty injustice, petty annoyance, and petty insult rather than take the trouble to correct such abuses of our good nature. When it becomes necessary to post notices in public places to prevent spitting on the floors, and when a leading periodical of unquestioned standing dares to print a full page editorial on the lack of common politeness and even common decency among the public servants of our greatest American city, what may we not expect? We have to pay twice for a good many things we have, and sometimes the second fee is bigger than the actual market price of the goods. Probably the time will never come when the machinist must give tips to get his rightful share of waste and oil and files, but would it be one whit more outrageous than some other cases of tipping that are of everyday occurrence?

The mud won't clear from the water as long as the current is swift, but it settles of its own accord when the stream flows deep and tranquilly. As long as we are living so fast that we haven't time to get acquainted with our own children, how can we be expected to cultivate the "amenities" of life unless induced to do so by liberal tips or fear of prosecution? It "wouldn't pay?" Well, perhaps not.

Society of all kinds requires a certain thickness of veneer over the rough outlines of the untamed human animal, but the kind that will be of value to the young fellow with a real purpose in life is very quick to detect the quality of stock hidden under the varnished covering. And I'm confident there is just as much good oak and rock maple in our human furniture to-day as there was before we cut off such an alarming amount of our primeval forest. Sometimes we hear an elderly man spoken of as a gentleman of the old school, as if that school no longer had any primary classes. And it is not so long since some musicians feared that with the death of Adelina Patti the old Italian method of singing would fade into the limbo of lost arts. But Melba and Sembrich appeared, and others are coming. Generations yet unborn will have their "gentlemen of the old school" and who shall say that none of these may be machinists?

* * *

The recent automobile show held in Madison Square Garden, January 12 to 19 inclusive, under the auspices of the Association of Licensed Automobile Manufacturers was a great success in point of attendance and the number of machines sold. Notwithstanding the fact that on Tuesday and Thursday of the exhibition week the admission was raised from 50 cents to $1.00, the total number of visitors is said to have been upward of 124,000. The reason for the increased admission price was to reduce the crowd to include so far as possible only those who were interested in machines to the extent of being possible buyers. Next year it is proposed to increase the admission price for two certain days to $5.00. But why not go one better and put every visitor on these days through a cross-examination as to his intention, financial standing, etc. In that way, the undesirable (?) crowd could be reduced to a mere handful which would waste little of the valuable time of the haughty automobile magnates. As a matter of fact, however, what the automobile manufacturers want is the fullest possible publicity. The more people know about their machines whether they are at present able to buy or not, the more possibility there is of selling machines in future. It is part of every manufacturer's business to manufacture a market as well as to supply the demand. The excuse given for the proposed exorbitant admission price is probably a subterfuge to cover a scheme by which some would seek to gain a large profit. We believe that the manufacturers will do well not to countenance such a scheme.

* * *

Next to "high polish and deep scratches" a highly polished but uneven surface is to be avoided. Nothing is more common, however, than to see metallic surfaces, especially brass signs and similar pieces, highly finished but wavy or irregular in contour, as can be easily detected when the light is reflected at a more or less acute angle. The effect is displeasing to the eye and largely offsets the value of the high finish. A highly finished metallic surface should first be made truly flat or cylindrical (as the case may require) by machining or grinding. Polish will then give a rich effect similar to that of plate or cut glass. Of course it is not practicable to do this in many cases, but where an extremely fine effect is required it should invariably be done.

ROUGHING AND FINISHING SPRING SCREW DIES.

ERIK OBERG.

In order to obtain uniform and well-finished threads when cut with spring-screw threading dies it is well known that it is necessary to use two dies, one for roughing and one for finishing the thread. In general practice the roughing die is obtained simply by adjusting a regular spring screw die of standard size to cut a certain amount oversize. This, of course, answers the purpose well enough for most classes of work for which this kind of die is used. It is evident, however, that there is no great certainty as to the relative amount of metal removed by each die, and it is most probable that the roughing die at least on larger sizes is doing far more than its fair portion of the work, leaving but a small amount of metal for the finishing die to remove. The latter die should, of course, not perform as heavy a duty as the former, but it is considered as a fair proportion to let the roughing die remove two-thirds and the finishing die one-third of the total amount of metal to be removed. In order to obtain such a proportion some firms who perform very close work by means of spring-screw dies make special roughing dies, enough oversize to permit the finishing die to cut the predetermined amount of the thread. These roughing dies are provided with perfectly-shaped threads, simply hobbed out with a tap which is the desired amount oversize as well on the top as in the angle of the thread. In this manner the finishing die will remove a certain amount of metal both on the top and in the angle, thus finishing the whole thread perfectly smooth and to the correct form.

It must, of course, be determined how much oversize the roughing die is required in order to leave one-third of the metal to be removed by the finishing die. This can be expressed in a simple formula with the pitch of the thread as the variable. In Fig. 1 the relative amounts of metal removed by the respective dies are shown in a diagram; we have here a United States standard thread where the amount of metal represented by the area *ABDC* is to be removed by the roughing die and the area *BEFGHACD* by the finishing die. The derivation of the formula we wish to obtain is as follows:

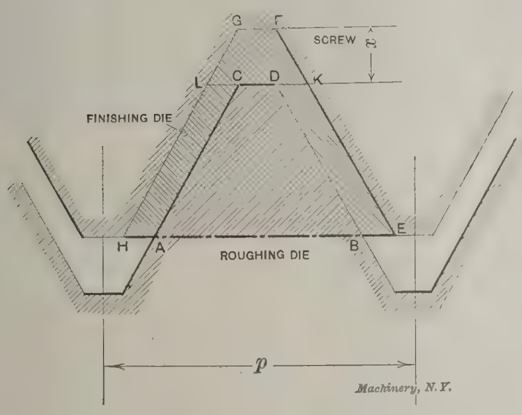


Fig. 1. Diagram of Metal Removed, United States Standard Thread.

The area of a section of a full V-thread with the pitch p is $\frac{1}{2}p^2 \times \cos 30$ deg. Subtracting from this the amounts

$\frac{1}{2} \times \frac{1}{64}p^2 \times \cos 30^\circ$, and $\frac{1}{2} \times \frac{1}{64}p^2 + \cos 30^\circ + \frac{7}{64}p^2 \times \cos 30^\circ$,

which represent the areas deducted from a full V-thread in order to obtain the area of a section of a United States standard thread, we find this latter area to be $\frac{3}{8}p^2 \times \cos 30$ deg.

Consequently the amount of this sectional area to be removed by the roughing die is $\frac{1}{4}p^2 \times \cos 30$ deg. and the amount to be removed by the finishing die $\frac{1}{8}p^2 \times \cos 30$ deg.

Referring to Fig. 1 we therefore arrive at the following equation:

$$\frac{1}{2}\left(\frac{7}{8}p - 2x \times \tan 30^\circ\right)^2 \cos 30^\circ - \frac{1}{2} \times \frac{1}{64}p^2 \times \cos 30^\circ = \frac{1}{4}p^2 \times \cos 30^\circ.$$

Solving this equation gives $x = 0.135\ p$ approximately. The diameter of the tap with which the roughing spring-screw die is to be produced should thus equal the standard diameter plus two times $0.135\ p$. This refers to United States standard threads.

For the same proportions between the amount of metal removed by each die, if a full V-thread is to be cut, the formulas are, of course, derived in the same manner, but have a different aspect. The area of a section of the thread is $\frac{1}{2}p^2 \times \cos 30$ deg. The amount of sectional area to be removed by the roughing die is consequently $\frac{1}{3}p^2 \times \cos 30$ deg.

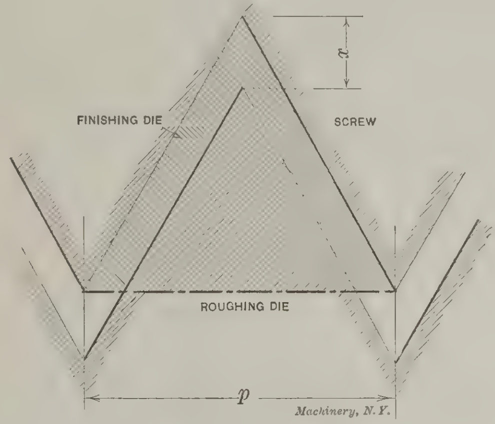


Fig. 2. Diagram of Metal Removed, Standard Sharp V Thread.

Referring to Fig. 2 we arrive at the following equation:

$$\frac{1}{2}\left(p - 2x \times \tan 30^\circ\right)^2 \cos 30^\circ = \frac{1}{3}p^2 \times \cos 30^\circ.$$

Solving this equation gives $x = 0.160$ approximately. Using this value the diameter of the roughing die is now easily determined.

If we wish to give formulas for the results obtained, we can express them in the following manner:

For the United States standard thread, $R = D + 0.27\ p$.
For sharp V-thread, $R = D + 0.32\ p$, in which formulas
R = diameter of roughing die,
D = standard diameter of finishing die, and

$$p = \text{pitch} = \frac{1}{\text{number of threads per inch}}.$$

It is, of course, of no great importance if the amount removed by each die is somewhat different from the values given, the amounts to be removed being arrived at in a purely arbitrary way from the beginning. But the proportions given conform to the practice of a prominent tool manufacturing firm, and the calculations are given to show that even in a territory largely given over to "guess work" there can be exact calculations made and adhered to. In toolmaking, as a rule, calculations form a very small part, and altogether too often is "a few thousandths over" or "a few thousandths under" considered the only way to determine certain values which, if once settled upon, could be formulated by simple figuring so as to serve as a permanent guide for the toolmaker. It is a mistake to think that toolmaking is so widely different in its nature from other fields of industrial progress that here no strict rules can be followed. It must be admitted that there is perhaps no field of mechanical achievement where opinions differ so widely as they do in regard to toolmaking. But that is no reason for continuing to consider toolmaking as a territory where no principles or rules can be concentrated in simple formulas, arrived at in a logical and common-sense manner.

STRUCTURAL FEATURES OF THE EDGWICK WORKS OF ALFRED HERBERT, LTD.

The new works of Alfred Herbert, Ltd., Coventry, England, are located at Edgwick, a little more than two miles removed from the head works, and adjoining their foundry. It is intended to carry on the Edgwick works as an entirely independent factory for manufacturing and finishing machine tools throughout. The new works will not be dependent upon the head works except in the provision of designs and in the manufacture of small tools, jigs and such special appliances. The principal works being at present fully equipped in these departments and having sufficient capacity to deal with the design of the machines and with the small equipment of both factories, it is, of course, best to utilize the same engineering department for the two plants.

The accompanying halftone shows the new building with the steel work erected, but not closed in, and will serve to give an idea of the general plan of construction and some of the interesting features thereof. The cut shows seven bays erected, but the plan includes eight bays in all, the eighth not having been erected at the time the photograph was taken. The width of the shop is 240 feet, each of the eight bays being 30 feet wide; the length of each bay is 100 feet, thus giving a shop floor area of 100 x 240 feet.

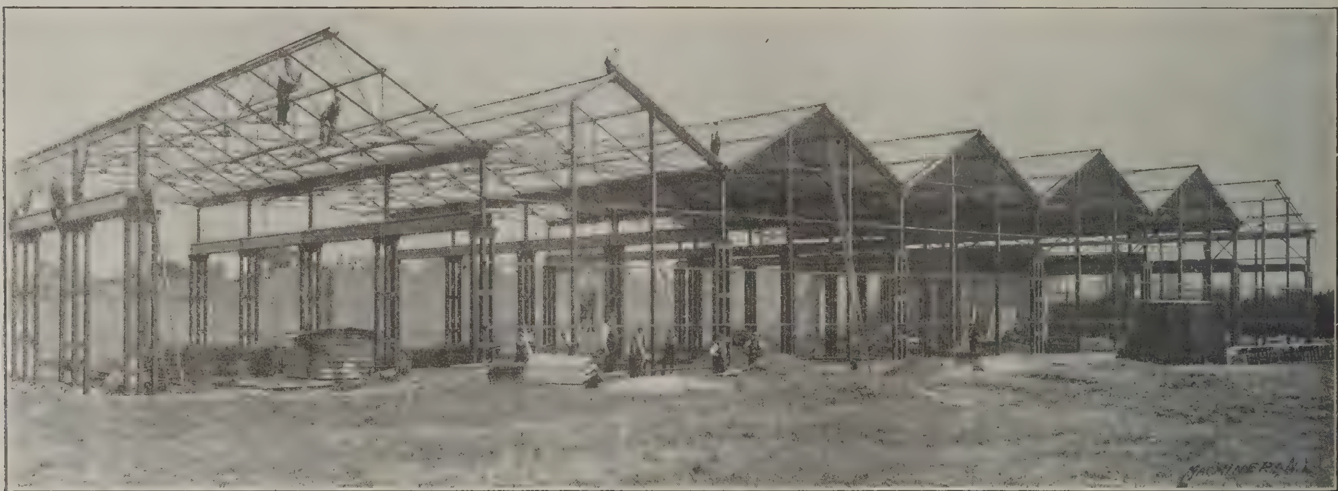
The plans provide for an extension to 240 x 400 feet all under one roof. The ends of the bays shown in the picture are covered by a screen, the framing of which is indicated in some of the bays; it is arranged that when the shop is extended the screen can simply be moved so as to form the end of the extension. All that will be necessary in making the extension will be to order from the mills the required number of additional columns, roof girders, etc., the work being interchangeable. The permanent end and side walls of the building are of brick.

In the design of the building, the intention has been that the roof shall be a roof pure and simple, that is, a covering with sufficient strength to support its own weight and to resist wind pressure, and of correct design to keep out the weather, but not to carry any additional weight or in any way to form any essential link in the framing of the structure. The stanchions or columns, which are of as simple design as possible, so as to avoid unnecessary cost, are carried on large footings imbedded in heavy concrete blocks, and are calculated to stand entirely by themselves without any assistance from the roof. The side members of each column carry the longitudinal crane girders in direct compression, no brackets being used. The central member of each column is prolonged upwards to carry the roof. It is calculated that the longitudinal girders placed on each column, together with the longitudinal gutter beams, stiffen the building so as to take all racking action away from the roof; this is still further provided for by the diagonal bracing, some of which can be seen at the extreme right and left ends of the cut. The roof is covered with corrugated sheets on the southern side and the northern side is entirely of glass. The southern side is lined with "uralite" sheets, the whiteness of which improves the light; it also diminishes sweating or condensation of moisture in cold weather.

The longitudinal girders which carry the crane rails are installed in every bay whether it be a crane bay or a machine bay; in bays where cranes are used the ordinary rails are fitted to the top of these girders, but in cases where no cranes are required and where overhead shafts and countershafts have to be erected these longitudinal girders serve as supports for cross girders to carry shafting and countershafting. It is thus possible, should the condition require the rearrangement of the shop in future, to put cranes up in any machine bay, or on the other hand to install machines in any crane bay without altering the framing of the building in any way.

The floor is composed of 8 inches of concrete in which are bedded nailing strips 2 feet apart. The floor boards are of 2-inch creosoted timber, nailed down to the strips bedded in the concrete. Although the greater part of the floor is of wood, certain portions have been heavily concreted and are finished with blue bricks laid in cement. These sections are for the purpose of testing, running, and erecting heavy machines as it has been found that the elasticity of floor boards militate against the accuracy of erecting heavy machines. The head room under the girders is 14 feet 6 inches and 21 feet to the gutters.

The stores or control department will run across the ends of the bays extending the whole width of the shop and will have an area of 240 x 20 feet; there will be two tramways extending the width of the shop with turntables in each machine bay, and longitudinal rails will be laid in each machine bay between the rows of machines. The tramway in each bay can run straight into the storeroom so that material can be delivered to and from machines in a very direct manner.



Structural Features of the New Edgwick Works of Alfred Herbert, Ltd., Coventry, England.

All shafting will be driven by motors with a separate motor to each lineshaft, and all bearings will be self-oiling. Individual motors will only be used for heavy machines. The lineshaft, of course, is laid out longitudinally in each bay and each bay thus becomes a separate unit so far as power requirements are concerned.

As the present building is only one-fourth of its destined ultimate size, a permanent power plant has not been ordered, and provision has been made in building both the boiler house and the engine room to extend each to four times the present capacity without disturbing the present arrangements of the boilers or machinery. In order to avoid excessive idle expenditure in the beginning, it has been decided to have a stack at each end of the main flue from the boilers. The stacks being identical and each one serving for half the total installation, it is therefore only necessary to build one stack at present, thus saving idle capital that will be involved in a large stack of sufficient size for ultimate installation. The boilers are Babcock & Wilcox with Green economizers. The engine is a 300 horsepower cross-compound Corliss type engine built by Robey & Co., of Lincoln. It is fitted with independent surface condensers and is direct connected to a multiple generator of 220 volts.

A VERTICAL MILLER AND A TURRET LATHE OF ENGLISH DESIGN.

Our friends across the water, both in England and on the continent, derive considerable pleasure from their belief that the vertical milling machine has reached among them a higher state of development and attained a higher degree of appreciation than in this country. If this is so, there must be reasons for it; admitting for the moment that their contention is true, we might venture one or two explanations for this hypothetical condition. In the first place America was the birthplace and early home of the horizontal milling machine in its practical points. Its characteristics and capabilities are well known and appreciated by every Yankee mechanic worthy of the name. When the milling of a piece of work is in question, the natural tendency of the mechanic is to do it on some kind of a horizontal milling machine, if it can be done there without obvious unhandiness. If the piece seems awkward to work in this way, he will, as an alternative, consider the adaptability of the vertical machine for the work; in other words, the burden of the proof lies with the vertical machine. Besides, of these two tools, the horizontal type is essentially adapted for manufacturing, while the forte of its competitor seems to be rather that of jobbing, or, at least, working on comparatively small lots. Formed cutters, elaborate gang cutters, and expensive holding fixtures are the natural accompaniments of the horizontal spindle. Face mills and end mills, with a sparing use of cylindrical cutting surfaces, characterize the vertical milling machine. These two conditions then—a predisposition for the familiar and the American fondness for work which can be handled in large lots—will account for the somewhat higher development of the vertical milling idea in Europe than here; although perhaps we would not be willing to admit the use of the words "higher development" as meaning much more than that a greater number of firms are there engaged in building these machines, and a wider variety of types is there met with.

An Example of English Vertical Miller Design.

The accompanying cuts will be instructive as an illustration of one of the lines of development which the tool under discussion has taken in Great Britain. They illustrate what Alfred Herbert, Ltd., of Coventry, England, designates as the "No. 8 patent vertical milling and profiling machine." Unlike the design common in this country and followed by the builder in small sizes, this size has no vertical adjustment for the work. The frame has all the characteristics of that of the slotting machine. In fact, if the spindle were replaced by a ram, and the geared feed changed to a ratchet feed mechanism, the machine would be transformed into a slotter with all its appropriate slides and holding devices.

One of the first things that will be noticed is the fact that there is no gearing in sight in either of Figs. 1 or 2, which show the right and left-hand sides respectively of the machine. This habit of covering mechanism is indigenous to England, and is shown especially in the design of their locomotives with the inside cylinders and concealed valve gear. With the machine in question, however, the increasing strictness of the factory inspection requirements had as much as anything to do with the matter, and the builder thought it best to meet all possible requirements by encasing every gear used on the machine.

The feed is driven by a separate belt from the countershaft, an arrangement which has an effect corresponding to that obtained with the gear driven milling machines of this country, in which the feed motion is obtained from a single speed pulley. With either of these arrangements all the feeds (stated in terms of distance traversed per minute) are available with any spindle speed; thus the coarsest feeds can be used with very large cutters running slowly, and the finest feeds may be obtained with small and delicate cutters running at high speed—two conditions unobtainable with the usual construction. The horizontal millers of the same builder are arranged to be driven either from the spindle or from the countershaft, as may be desired by the purchaser.

A "dial" feed mechanism is employed, which is contained in the casing shown in Fig. 1 at the foot of the column of the machine. A handwheel is provided with an attached dial which is graduated for sixteen different positions. To obtain any one of sixteen feeds it is only necessary to move the handwheel until the dial shows the proper reading, no other movements being required. These feeds are arranged in geometrical progression, and by suitable levers and clutches may be applied either to feeding the saddle toward or away from the column, feeding the platen to the left or right, or rotating the circular table in either direction. Automatic and dead stops are provided for all these different motions.

The main table is very heavy and is provided with suitable channels for taking care of the lubricant used on the cutter. A covered way, which is thus protected from being clogged by chips, leads the oil from either end to the outlet pipe.

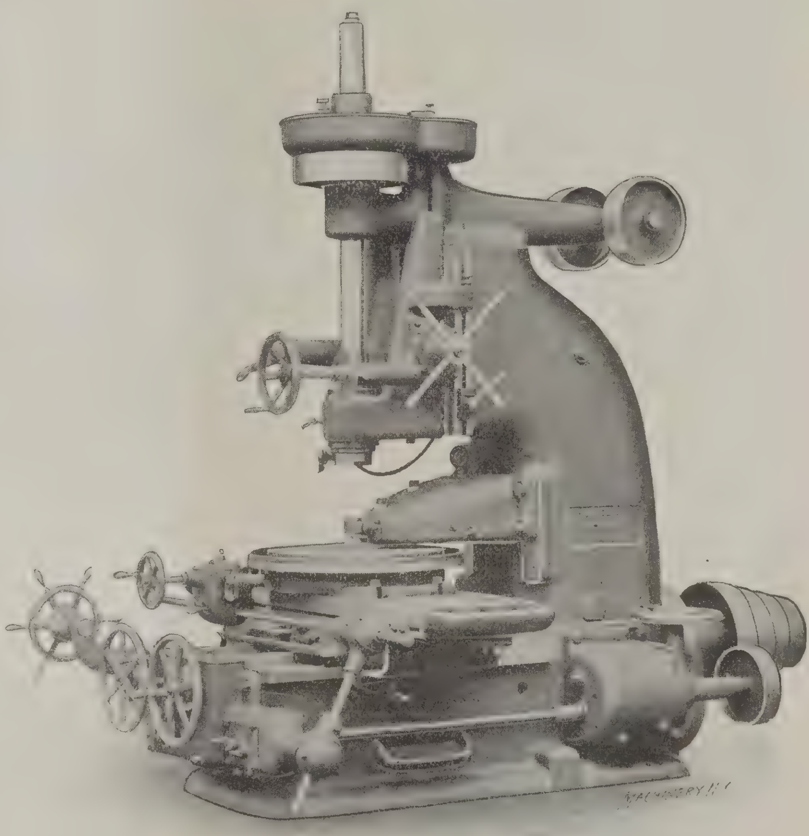


Fig. 1. Vertical Miller built by Alfred Herbert, Ltd., of Coventry, England.

The builders make a point of the great rigidity of the table, which prevents distortion under the strain due to clamping the work. The sliding surfaces both for the round and longitudinal tables and the saddle have self-oiling provisions, and the reservoirs for these can be reached from the sides of the table without disturbing the work that may be clamped on it. All slides are fitted with clamping devices.

The spindle has 16 speeds in geometrical progression. It is of crucible steel, journaled in phosphor bronze boxes, which are provided with independent adjustment for diameter and end play. The belt pulley which drives the spindle is carried by a sleeve in the customary manner to prevent carrying the belt pull to the spindle bearing. The sliding head is counterbalanced and has both a fast and slow hand adjustment; the handwheel and clamping lever are brought well to the front so as to be easily accessible.

Description of the Profiling Attachment.

The machine shown in Figs. 1 and 2 is provided with a profiling attachment, which will be better understood by re-

ferring to Fig. 3, which illustrates the way in which the device is used. A heavy outboard support for the end of the cutter is provided. This support may be placed in either of two vertical positions, one of which is suitable for use with the circular table, while the other may be employed for working on the main platen. This support may be swung about a pivot on the left side of the machine so as to be out of the way when it is not in use. An eye-bolt, conveniently placed, furnishes a means of shifting it from its lower to its upper position, or *vice versa*. On the under side of this support, provision is made for attaching a roll to follow the former for profiling work. To adjust the depth of cut this roll may be shifted in or out independently of the guiding bushing for the cutter. In Fig. 3 a piece of irregular contour is shown mounted on the circular table in conjunction with a former, which is the lower of the two parts. The main platen is fed longitudinally, and the former is kept in contact with the roll by the action of a weight and its connected mechanism, shown near the base of the column at the left in Fig. 3; arrangements are made for permitting this weight to act independently of the cross-feed screw. The pilot wheel and attached pinion meshing with rack teeth cut in the radius rod running to the weight lever furnish means, when so desired, for withdrawing the former from contact with the roll and the work from contact with the cutter.

Taken altogether, so far as one can judge from the photographs provided, this machine and the members of its family, both horizontal and vertical, give evidence of careful attention to the details of design, and indicate a high state of development in the art of using the class of tools to which they belong.

A Hexagon Head Turret Lathe.

It will perhaps be interesting to compare a turret lathe by the same maker with American machines of its class. Fig. 4 shows the No. 2 patent hexagon turret lathe built by Alfred Herbert, Ltd. It will be noticed that the single speed pulley gear-driven type of headstock is used, with which 16 variations are obtained in the machine shown. The merits of this arrangement are so well known as not to require discussion. The same "dial" feed used in the vertical miller just described is applied to this machine as well, the handwheel and dial for operating it being shown just beneath the clutch levers on the headstock.

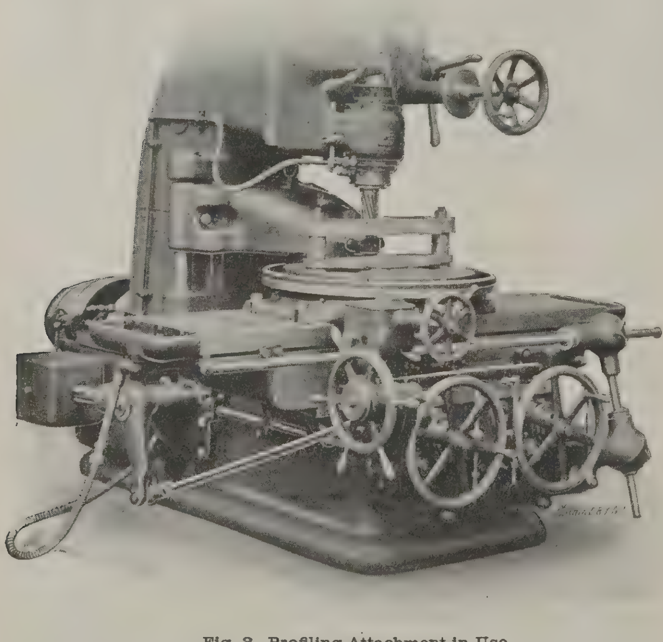


Fig. 3. Profiling Attachment in Use.

The long lever at the right of the headstock operates the chuck and stock feed mechanisms. The chuck is said to be especially effective and may be opened and closed while the lathe is running. Round jaws are supplied for round bars, giving more gripping power than is obtained with flat jaws;

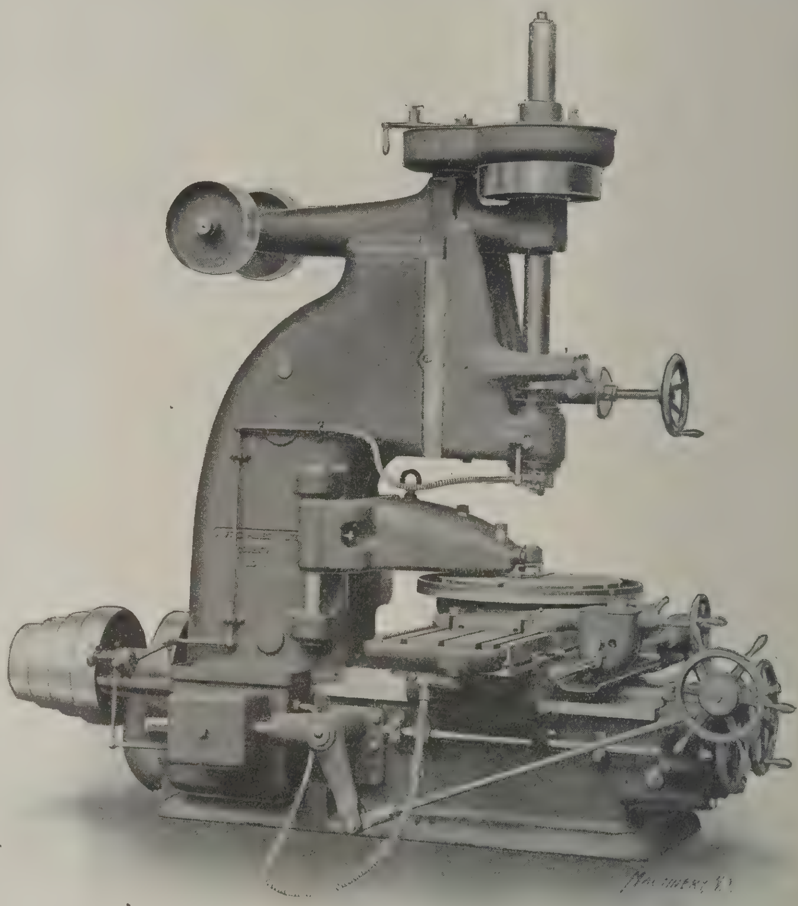


Fig. 2. Left-hand Side of Miller.

it is also claimed that the flat jaws do not allow work to be truly held by a finished surface for a second operation. Each jaw is in four sections, but it is recommended that only three of them be used when holding stock that is somewhat out of round. For holding square and hexagon bars flat jaws are provided.

The turret, as is indicated by the name of the machine, is of the hexagon type and is mounted on an unusually long slide, which is designed to pass beneath the end of the spindle when working with the tools close to the face of the chuck. This gives a good support for heavy cuts. The automatic stops are twelve in number, two for each position of the turret. They are clamped in the slots in the hexagon bar extending along the front of the bed, which bar is geared to rotate with the turret. The two stops are adapted to trip in succession on the forward movement, or one may be used for a forward stop and the other for a backward one, or both may be used for the reverse feed. A positive abutment, as well as an automatic trip, is provided by these adjustable stops. A large disk carrying three adjustable dogs on its periphery will be noted attached to the hub of the pilot wheel. Each of these dogs carries graduations which may be brought in line with a stationary pointer; this combination enables accurate lengths to be obtained within very fine limits of error. Besides this, for roughly gaging the length of cut, a scale is attached to the bed at the rear of the slide, which carries an adjustable pointer. This pointer may be set to an even foot dimension at the beginning of a cut, whose length may thus be read without directly measuring it on the revolving work.

Description of the Tools Employed.

Some idea of the tools employed may be gained from Fig. 4; four of the six ordinarily used are visible. Commencing at the left the first two are regular turning tools, the holders for

which are so arranged that cutters of a style familiar to the ordinary lathe hand are used. The cutter holder is a solid block of steel and is adjustable for diameter by a knurled knob, with the same facility that a slide rest is. When the cutter is once set for the correct height, no change is required for work of any diameter. The movement of the cutter is controlled by an adjustable stop which permits it to be withdrawn after finishing a piece of work, so as not to injure it when running the turret back; this stop is located in line with the screw which controls the movements of the cutter holder, so there is no springing of the structure. Steady rests are provided to support the work and act as burnishers, giving a smooth finish even when a heavy reduction is being made. A perfect finish is obtained, for instance, when reducing a 2-inch bar to ½-inch diameter at one cut. A point claimed for the holder and cutter employed is that downward wear on the top of the bed does not affect the diameter of the work, as is the case with end cutting blades acting on the top of the revolving bar. For reverse turning, that is, cutting away from the chuck instead of toward it, the only change necessary is to substitute a left-hand cutter and reverse the automatic feed by the handle provided for that purpose. This is advisable in slender work of considerable length.

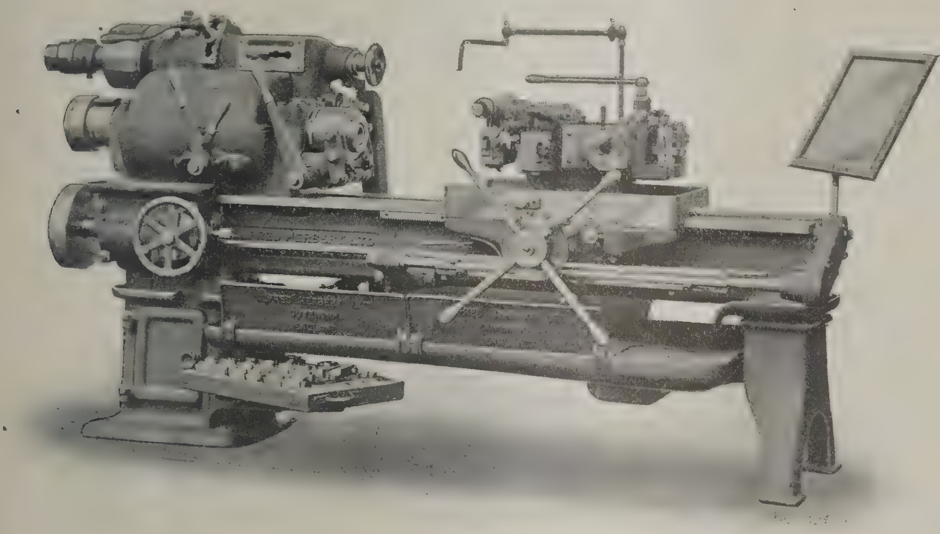


Fig. 4. Alfred Herbert Turret Lathe.

The opening die holder shown carries four chasers of the milled type, so arranged that the rear teeth act as burnishers and guiding surfaces for that part of the thread already cut, thus ensuring finely-finished threads and accurate pitches; it is provided with an arrangement which allows a roughing and a finishing adjustment, independent of the setting for size. The tool at the extreme right is a cross slide, carrying two toolposts, operated by a lever and pinion arrangement. One of the tools may be used for cutting off, the other being the forming tool. Besides these appliances, a triple holder (not in sight in the illustration) is employed. This carries three tools, an adjustable stop, a centering tool, and an end rounding tool—thus giving in effect two additional faces to the turret. A taper turning tool, not shown, is also provided for right and left-hand tapers of any angularity desired.

* * *

A remarkable bridge-building feat is reported from Canada, in connection with the St. Maurice Valley Railway, which has been built to connect the Shawinigan Falls and the Canadian Pacific Railway at Three Rivers. In order to win the large subsidies offered, it was necessary to complete the line—twenty-two miles long—by the last day of 1906. There were two heavy bridges to be built, and one, known as the Gorge Bridge, which was 135 feet high and 330 feet long, was not begun till December 15. With fifteen days to do the work in, the builders put on three shifts of men, and kept them going, with the result that the last rivet was driven in at 11:45 P. M. on December 31. The first train passed over the completed road before midnight.—*Page's Weekly.*

THE CONSTRUCTION OF SPLIT DIES FOR PRESS WORK.

C. F. EMERSON.

A die of great importance in the production of sheet metal parts is the split die. There are two principal reasons for using the split die. One is that it sometimes happens that the blanks to be cut are of such a shape that the die can be more quickly and cheaply made by making a split die than by making a solid or one-piece die. The other reason is that when the required blank must be of accurate dimensions, and there is a chance of the solid die warping out of shape in hardening, the split die is preferred because it can be much more easily ground or lapped to shape.

Fig. 1 shows the manner in which the ordinary split die is usually made. After the die is worked out it is hardened and ground on the top and bottom. The two sides *A* are then ground at right angles with the bottom.

The cutting parts of the die, *B*, are next ground at an angle of 1½ degrees with the bottom, so as to give the necessary clearance in order that the blanks may readily drop through. The key *D* is now set in place, and the die is keyed in the die bed by the aid of a taper key. The key *D* prevents the die from shifting endwise; the keyway should have rounded corners as shown, which not only give added strength, but also act as a preventative to cracking in hardening. The last operation is to grind the two circular holes. This is done by first lightly driving two pieces of brass or steel rod into the holes until they are flush with the face of the die. The exact centers are then laid out and spotted with a prick punch, care being taken so as to get the centers central with the sides *B*. The die is now fastened to the faceplate of a universal grinder, and the center mark is trued up with a test indicator until it runs exactly true. The brass rod piece is then driven out, and the hole ground to size, with 1½ degree taper for clearance. The other hole is next ground out in a similar manner which completes the operations in so far as the die is concerned. It often happens with a die of this kind that

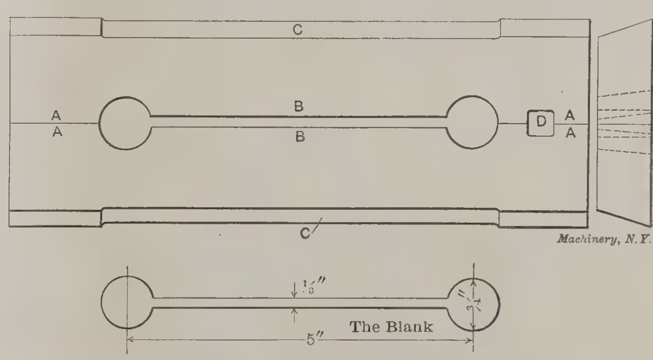


Fig. 1. Example of Split Die.

when it is placed in the die bed and the key driven in place, it will "close in." To overcome this the die is relieved after the manner shown at *C*, which does not in any way prevent it from being securely held in place when in use.

Fig. 2 shows a rather novel form of a split die; this die with a slight change practically takes the place of two dies. It is used for piercing slots in brass plates. The size of the slot for one style of plate is 4⅜ inches long by ¼ inch wide; for the other plate the slot is 4 inches long by 5-16 inch wide. The cutting part of the die, shown in Fig. 2, is made in four sections, *A*, *B*, *C*, *D*. The cut fully explains itself and therefore needs no detailed explanation. It may not be out of place, however, to say that the soft steel bushings, as shown, are used to allow for the contortion of the parts *A* and

B in hardening. It may be added that the four bushings shown in the piece *A* were driven in first; then solid pieces were driven in the part *B*; then the holes were drilled in these latter pieces, being transferred from the bushings in the part *A*. In Fig. 2 are also shown the parts used in connection with this die for piercing the 4 x 5-16 inch slot. These parts are made as shown, and are hardened only at the cutting ends. Outside of the fact that this style of die practically takes the place of two dies, there is still another feature in connection with it that will bear mentioning; there is no special or extra die bed required for this die when in use.

It may not be amiss at this time to say a few words with reference to die beds. The writer prefers to use the name die clusion that the taper-key method of holding blanking dies in the die bed is the best of the various methods he has come in contact with. The set screw method he considers the poorest of all. The key as shown in Fig. 4 is driven in on the front side of the die bed. This is optional, however, as the practice differs. In some shops the key is driven in on the front side while in others it is driven in on the back.

Of late years there has been a tendency among large concerns to have all their die beds for the power press made from semi-steel castings, or of machinery steel for certain classes of heavy work, instead of from gray iron as heretofore. This is being done because a gray iron die bed that is used day after day for holding dies for cutting heavy metal will not

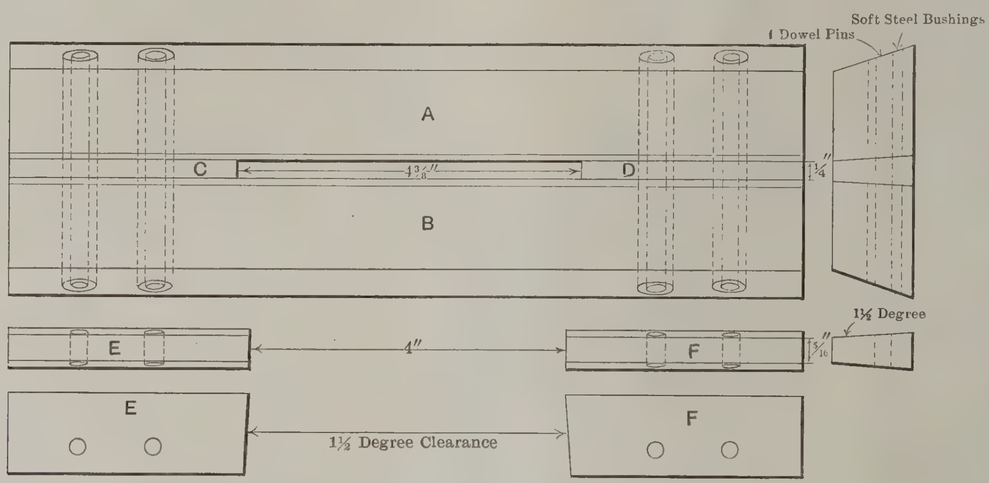


Fig. 2. Die with Interchangeable Parts, permitting Two Sizes of Blanks to be Punched by Changing the Center Pieces only.

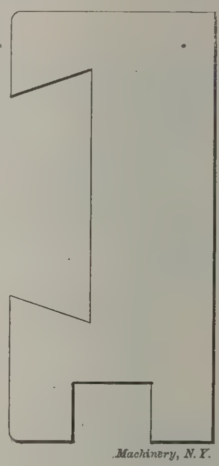


Fig. 3. Gage for Planing Die Blanks.

bed, for the reason that he thinks it is the most appropriate name. In some shops, however, this part is called bolster, die block or die holder. Perhaps the most commonly used and the best die bed for general use in the press room is the style of bed shown in Fig. 4. A similar style of die bed was described by the writer in the January, 1905, issue of MACHINERY; the die bed then referred to, however, was used for holding cutting and drawing dies. The die bed, as shown in Fig. 4 is principally used for the reason that the screws that fasten the die bed to the bed of the press do not have to be screwed entirely out, either in placing the die bed in the press or in taking it out, as the slots *C* and *D* are made at right angles with each other for just this reason.

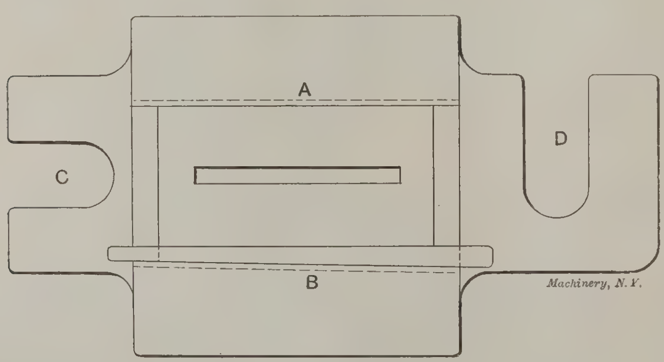


Fig. 4. Example of Die Bed.

The dovetail channel is planed so that when the die is keyed in position the center of the die is central with the slot *C*. The side of the die bed marked *A* is planed at an angle of 10 degrees, and is parallel with the slot *C*. The side marked *B* is planed at an angle of 13 degrees and is at an angle of 1 degree with the centerline. The reason for planing this side to an angle of 13 degrees instead of ten is that the increased angle causes the die to lie flat, and prevents it from raising or tilting up in any way when the key is driven in.

In speaking of the key the writer may add that from a mechanical and economical standpoint he has come to the con-

stand up during long and hard usage as it should. Past experience has proven that gray iron die beds in time become out of square; then, again, they sometimes crack. With the semi-steel, or the soft steel die bed, this does not happen. It has been found that semi-steel and machine steel die beds pay for themselves many times over.

In planing up the stock from which the blanking dies are sawed off before they are worked out, a gage similar to the one shown in Fig. 3 should be used for planing up the different widths of dies. In this way the dies will be of a uniform width and thickness, which makes it possible to have them interchangeable with the respective die beds for which they are used.

* * *

Nothing could be more suggestive of the method of transporting air than the word "fluid," which in its derivation means to flow. Wholesale transportation of a fluid is best accomplished, not by carrying, but as the very name indicates, by allowing it to flow always toward the point of least resistance. The transportation of fluids, of which air and water are the most familiar examples, results from the creation of a pressure difference between the delivery and receiving points. Ventilation, which as a process is the continuous removal of air from a closed space, is but the result of the natural or artificial creation of such conditions. When any considerable resistances have to be overcome, artificial means must be employed. The working of deep and extended mines has only been made possible by the provision of mechanical means in the form mof the fan blower by which air in adequate volumes can be furnished to the workers. The first crude application of a fire at the mine outlet for the purpose of heating the air and producing flow was long ago superseded by the fan designed to insure positive action.

* * *

A St. Paul dispatch says that the state of Minnesota expects to raise to $400,000,000 the taxable valuation of the Hill ore lands, in view of the basis on which the recent lease was made to the United States Steel Corporation. It is stipulated in the lease that the Hill interests are to pay all taxes. Heretofore, it is stated, the assessed valuation of the properties has been approximately $30,000,000.

A SHAPER MOTION MODEL—ANALYSIS OF THE MOVEMENT.

Considerable attention is given in technical schools to the study of kinematics, a science which deals with the way in which motion is modified by mechanism. Extensive use is made of models in studying this subject. We show in Fig. 1 an apparatus of this kind recently furnished by the Mark Flather Planer Co. of Nashua, N. H., to the engineering school of the University of Michigan. It consists essentially of a 15-inch shaper, their smallest size, with the table and feed mechanism removed, and with the ram driving parts mounted in a special frame, so as to leave one side open with all the parts exposed to view. Instead of having a ram, this machine is provided with a short slide only. The mechanism of the Flather shaper, which is thus displayed for the benefit of the students, is well known, and has been in use for many years. The line drawing, Fig. 3, and a brief description will serve to describe it so that its action will be understood. The arrangement shown in Figs. 1 and 3 has of course been modified somewhat in adapting it for use as a model, and the parts are not in all cases so strongly supported as they are with the double frame of the regular shaper column; the kinematic action, however, is identical.

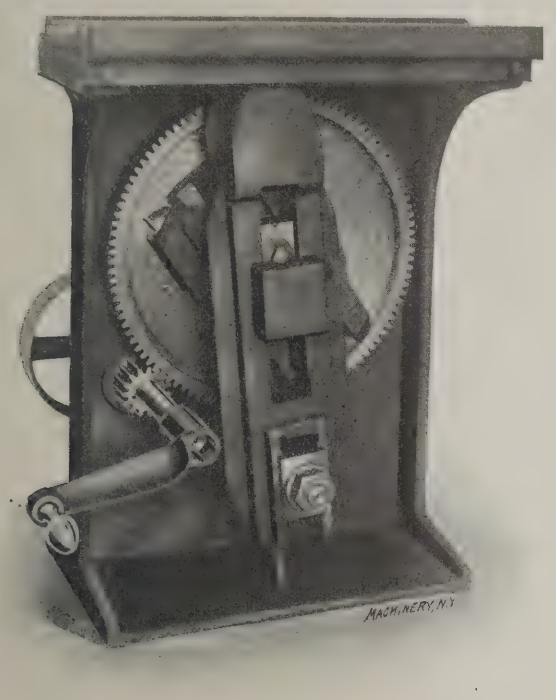


Fig. 1. Shaper Motion Model, built for an Engineering School.

Pinion M is driven by power or hand as may be required, either by the pulley shown or by the crank. This pinion meshes with the driving gear L, whose shank is journaled in a babbitted bearing in the side of the frame B, and is supported as well by a bearing on the outside of block O, which is bolted, in turn, to the frame. The driving gear has thus a double bearing. It carries a block, P, pivoted in a slot in the inner face of the crank slide N, whose axis is set eccentrically with that of driving gear. Gear L, block P, and slide N, form a modified Whitworth quick return movement of the kind commonly employed in slotting machines. The shank of the crank side N is journaled in a bearing in O, which enters a hole in the axis of the main driving gear and is bolted to the frame as before mentioned. For adjusting the stroke, crank N is provided with a slide, F, carrying the crankpin block, E. This slide may be adjusted toward or away from the axis of the crank by means of the scroll rack H attached to it, and the scroll G. As this scroll is rotated by the crank through shaft J, the rack H is moved out or in, and with it, the crankpin. Hand wheel K serves to lock the mechanism after the adjustment is made.

Crankpin block E slides in a slot in link C. This link is pivoted at the top to slide A as shown, and at the bottom has a forked end embracing the block on stationary pivot D. Adjustable crankpin E, link C, slide A, and pivot D, constitute a modified quick return movement of the kind usually provided for shapers, the only difference from the common type being the fact that link C is pivoted at the ram and slides longitudinally over the lower pivot D, while in the usual construction the link is pivoted at D and adjustably connected to the ram at the top. This change in the usual construction was originally undertaken to bring the sliding part of the mechanism to a position where it would have less wear than in the standard construction, but besides this, the change was found to have a good effect on the quick return function of the device, since it lengthens the upper end of the link and thus keeps up the cutting speed of the tool toward the end of the stroke at a time when the ram would naturally be slowing down.

For the sake of suggesting to draftsmen a method by which a motion of this kind may be analyzed and compared with other mechanisms to determine their relative value, we have here made a graphical determination of the velocity of the cutting tool at all points in the stroke. In doing this we had nothing to go by save an undimensioned assembled drawing, so that perhaps the results obtained may not tally strictly with actual conditions, but the results found are very good, and may be as easily obtained as poorer ones in this mechanism.

There are a number of ways of attacking the problem. We might, for instance, if we knew enough and had the patience, analyze the mechanism and deduce a formula giving the position of the shaper ram for any angular position of driving gear L, which is assumed to move at constant velocity. From this formula we might obtain by the differential calculus a second expression that would give us the velocity of the ram for any position of the driving gear. We will take, however, for illustration, a graphical process, being moved thereto by compassion for both writer and reader. Of the several ways in which the problem may be attacked graphically we have chosen what seems to be the simplest and quickest.

Fig. 2 presents a skeleton diagram of the mechanism. In laying it out, care should be taken to see that the dimensions

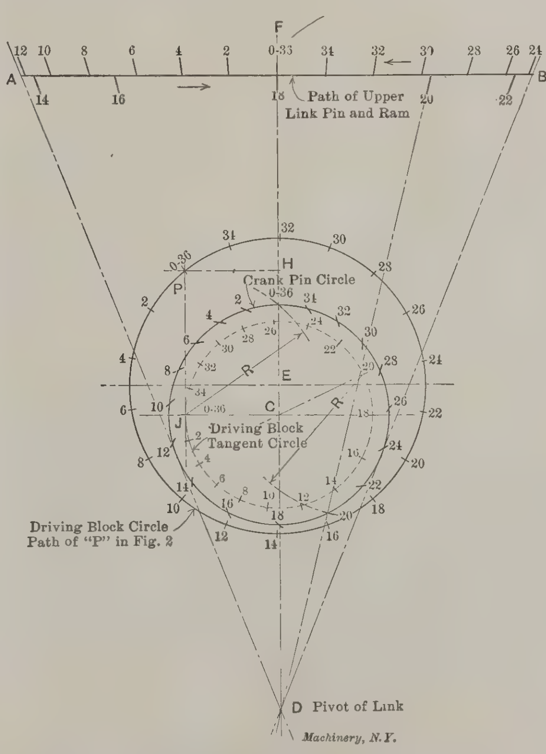


Fig. 2. Diagram showing Analysis of the Movement.

of the working drawings are carefully followed. FD is a vertical line drawn through the center of the driving gear and the link pivot D. AB is the path of the axis of the pivot at the upper end of the link. Draw the driving block circle with center E, the radius used being the distance from the axis to the center of the driving block pivot. In Fig. 3, the mechanism is shown at mid-stroke with the link vertical. In Fig. 2 determine the position of P, the pivot of the driving

block when in the position of Fig. 3, making $P\ H$ the same in each case. Starting at P divide the driving block circle into 36 equal parts, of which the even numbers only need be marked. It is now required to find out what angular advance will be given to the crank for each even advance of the driving block from station 0 to station 2; station 2 to station 4, etc.

Drop a vertical line from P and draw a horizontal line through C, the center of the crank. With C as the center, draw the driving block tangent circle, tangent at J to the vertical line through P. Through each of points 2, 4, 6, 8, etc., on the driving block circle, draw tangents to this tangent circle, and mark the points of tangency 2, 4, 6, 8, etc. Line $P\ J$ represents the direction of the slot in the crank which engages the driving block P, and a moment's consideration will show that on this account the points we have thus determined in the driving block tangent circle, will mark off the angular movements given to the crank for each even angular advance of the driving wheel.

It is now required to find the position of the crankpin for each position of the driving block P. With center C draw crankpin circle with radius equal to the distance of the crankpin from the axis of the crank at full stroke. When the driving block is at station 0, or point P, the crankpin is on the vertical axis of the mechanism at the station marked 0 in the diagram. To locate its other positions, with the dividers set for a distance R equal to the distance between station 0 at J on the driving block circle and station 0 on the crankpin circle, step off from point 2 on the driving block circle, point 2 on the crankpin side, point 4 from 4, point 6 from 6, and so on. This construction is shown only in the case of station 0 and station 20. The operator merely transfers the angular movements from their position on the smaller circle to their place in the larger circle without changing their value or arrangement.

We may now find the position of the ram for each station on the driving block circle. Draw a straight line through D, the center of the lower link pivot, and each station of the crankpin circle. The point where this line crosses $A\ B$, the path of the upper link pin, will determine the location of that link pin for each position of the driving gear. The construction is shown in the case of position No. 20. Tangents to the crankpin circle drawn through D determine, on line $A\ B$, the two extremes of the stroke. All this will be readily understood from a comparison of Figs. 2 and 3.

Our problem is now to draw a curve representing the velocity of the ram at any instant. If we are in a train, moving at a constant speed, and we have passed over 70 feet in the last second, we are evidently traveling at the rate of 70 feet per second, and that is the velocity of the train. If the train is traveling at a constantly increasing or constantly decreasing velocity, and we have traveled 70 feet in the last second, we may say with assurance that when half that second had elapsed, we were traveling at the rate of 70 feet per second. In the case of our mechanism in a similar way, (if we conclude that our stations 0, 2, 4, etc., are so close together that the acceleration or rate of change of velocity is practically constant for the time considered) we may take the distance between any two positions of the ram, 0 and 2 for instance, as a measure of its velocity at a point half way between these two positions.

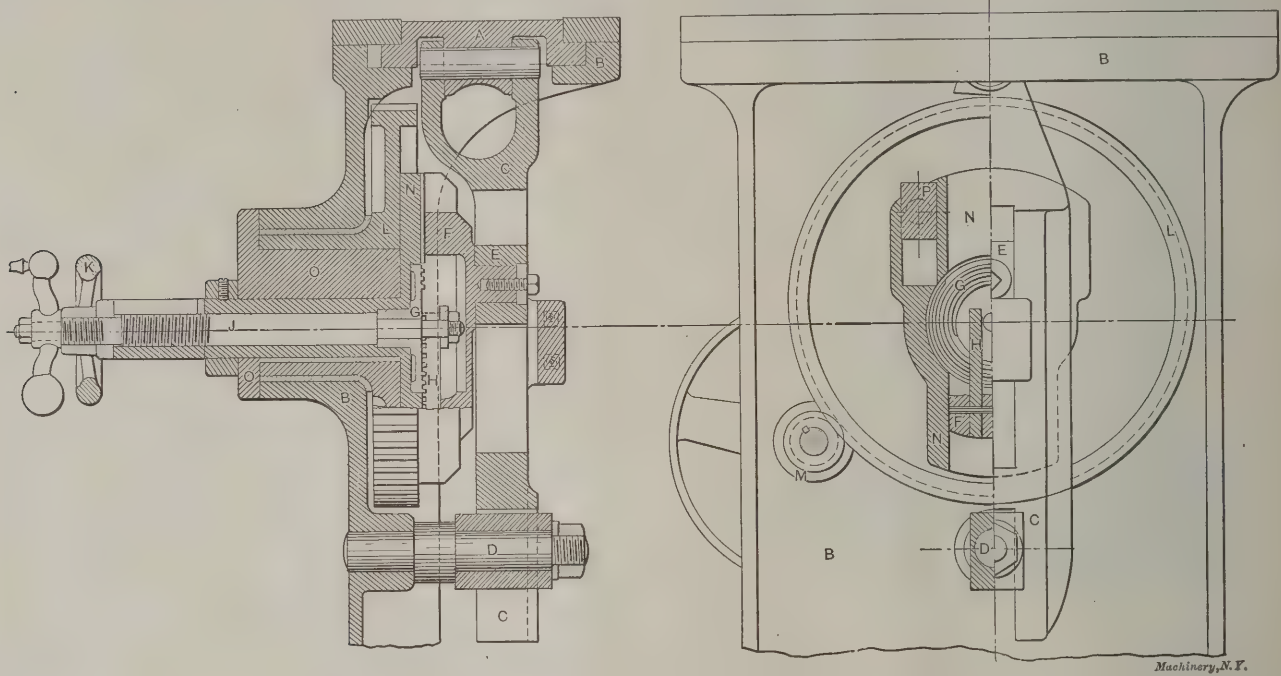


Fig. 3. Construction of the Quick-return Mechanism for Driving the Ram.

In this way the diagram in Fig. 4 was constructed. Horizontal line $O\ O$ is drawn, crossed by vertical lines 1, 3, 5, 7, etc., at equal distances, representing the equal elapsed periods of time when the driving wheel occupied positions intermediate between stations 0, 2, 4, 6, etc. As before intimated, we lay off on line 1 a distance above line $O\ O$ equal to the distance between positions 0 and 2 of the ram as measured on line $A\ B$ in Fig. 2. In a similar way on line 3 in Fig. 4 we lay off a distance equal to that between stations 2 and 4 of line $A\ B$ of Fig. 2 and so on up to line 11. Now, on line 13

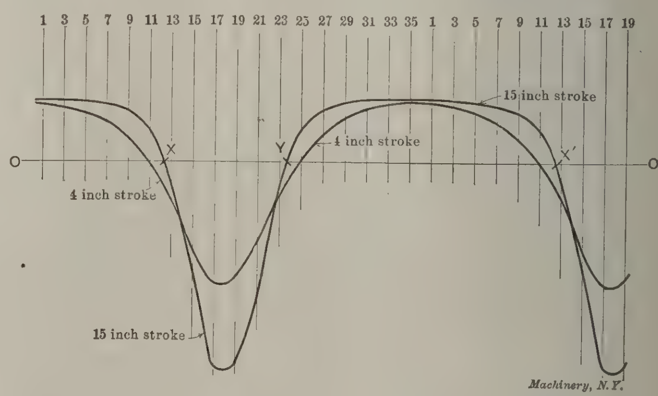


Fig. 4. Velocity Diagram for the Tool for 15-inch and 4-inch Strokes.

we should lay off the distance between stations 12 and 14 on line $A\ B$, but it will be noticed that in measuring the distance in serial order from the lower number to the higher we have commenced to measure backward. This we will consider as giving a negative value to our distance, so it must be measured off below the datum line in Fig. 4. Proceeding, on line 15 a vertical downward distance is laid off equal to that between stations 14 and 16 of $A\ B$ and so on, the dimensions again becoming positive at line 25. After station 35 is reached we may commence over again in order not to

end the curve at an inconvenient point. Through the points thus determined we will draw a curve represented in the diagram by the 15-inch stroke line.

This curve shows us what we want to know. It shows us that between X and Y the velocity is negative, that is to say, the tool is on the backward stroke, while between Y and X' the velocity is positive, when the tool is advancing. The relative lengths of XY and YX' will then give us the relative time taken for the cutting stroke and the return stroke. Besides this information (which might have been otherwise obtained) the shape of this 15-inch stroke curve tells us what we want to know about the mechanism as a quick return device. It will be noticed that the top of this curve is remarkably flat, thus showing that the velocity is nearly constant throughout the greater part of the length of the cutting stroke. Since this is one of the things to be sought for in a movement of this kind we may conclude that in this respect the mechanism is fulfilling its function in an exceedingly satisfactory way.

If in Fig. 2 we had taken the diameter of the crankpin circle as that required to give the ram, say, a 4-inch stroke, but had followed in all other respects the procedure just described, we could obtain a curve on the diagram giving relative velocities for different positions under these circumstances. Such a curve is shown in Fig. 4, but for the sake of comparison with the 15-inch stroke curve this 4-inch one has been exaggerated or drawn to a larger vertical scale, so that its maximum forward velocity corresponds nearly to the maximum forward velocity of the ram in the 15-inch stroke. This vertical exaggeration, as we may call it, corresponds to the action that takes place when the belt is shifted to a smaller step on the driving cone for the short stroke, so that the action is entirely justifiable.

In the usual shaper mechanism, the quick return motion rapidly loses its effectiveness as the stroke is shortened. The introduction of the intermediate Whitworth device, however, preserves to a large degree the quick return characteristics even at this very short stroke, as well be seen from an examination of the curve. A similar analysis of a plain slotted link arrangement would not have shown as satisfactory a result.

General instructions for using this method of investigating velocities may be given in these words: By construction, show the position of the driven member at each of a number of small equi-distant intervals of time. Measure in regular order the distance between the stations thus obtained, and mark off these distances on successive ordinates on cross-section paper, measuring the distance above the datum line for measurements taken in one direction and below the datum line for measurements taken in the opposite direction. If a curve is drawn through the points thus obtained, it will be a fair representation of the velocity of the moving elements whose action it is desired to study, providing the work has been carefully done and the stations have been taken at reasonably short distances apart.

* * *

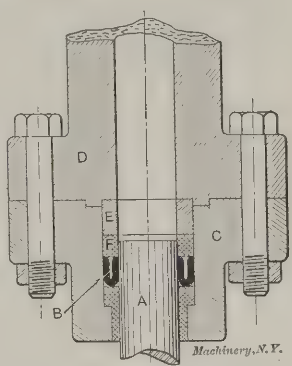
As the subject of endurance of taps has of late been given some attention in MACHINERY, it would perhaps be well worth mentioning that Mr. George M. Bond, who has been intimately associated with the establishment of gages for the U. S. standard thread, said in a lecture before the Franklin Institute in 1884 that a certain nut-manufacturing concern by using the U. S. standard thread form had been able to cut the threads of 120,000 nuts with a tap of 3/16 inch diameter. If we assume that the thickness of a 3/16-inch nut is about 0.2 inch the continuous length of thread cut would be 24,000 inches, which certainly is remarkable for this size tap.

* * *

The watering of railroad stock with consequent results upon rates is exemplified in the case of the Great Northern which is now paying dividends of 7 per cent annually on $150,000,000 capital stock and, it is claimed, intends to pay the same rate of dividend on the capital stock after it is enlarged as proposed to $210,000,000. The road's patrons, mainly the people of Minnesota, will probably have to pay the difference, which would be $4,200,000 a year, very likely without receiving any direct benefits.

HYDRAULIC STUFFING BOX PERMITTING OF EASY RENEWAL.

Designers and users of hydraulic machinery sometimes prefer the use of a stuffing box with soft packing for piston rods and rams of moderate size, even though it is less effective and wears much more rapidly than does the U-packing ring of leather. The objection to the leather packing is that it has seemed necessary to install it in such a way as to make renewal of the packing rather difficult. That this condition is an avoidable one will be seen from the accompanying cut, which represents the ram and packing of the steam intensifier used with the rapid-action forging press built by Davy Bros., Ltd., of Sheffield, Eng. The ram A is shown at the lower extremity of its stroke. It and the packing B are supported by the sleeve C, which is an extension of the cylinder D. The joint between C and D is one easy to make or break, and to keep tight. Within a counterbore formed in the sleeve C are inserted two rings, E and F, above the U-packing. To renew the packing it is only necessary to lower the ram to the extreme position shown, remove the bolts holding the sleeve C to the cylinder and then drop the sleeve out of the way. Ring E may now be withdrawn from the sleeve and slipped out sidewise, there being room enough left between the top of the ram and the lower face of the cylinder for this purpose. In the same way F may be removed and with it the packing. After this is renewed the operation is reversed, rings F and E are inserted, bushing C is reclamped to cylinder D, and the press is again ready for work. This operation can be performed in a few minutes, whereas without this device the insertion of a new leather necessarily occupies a good deal of time, involving considerable labor and interfering with the use of the press.

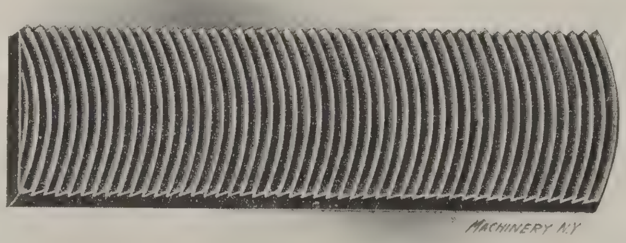


Hydraulic Stuffing Box Permitting of Easy Renewal.

* * *

A CIRCULAR CUT FILE.

What is stated to be a simple and radical improvement in the manufacture of files consists in the method of circular cutting adopted by the Patent File & Tool Co., London, on the files manufactured by them. The shape of the teeth and method of cutting are shown in the accompanying illustration, taken from the *Engineering Review*, London, January, 1907; it will be seen that the grooves are semi-circular in outline and are cut very deep. It is stated that this method



Circular Cut File.

of tooth formation enables the file to cut without slipping or running to the side, and insures superior cutting qualities to those possessed by the ordinary file, besides enabling the tool to retain the cutting edge for a longer period. Furthermore, owing to the shape of the teeth, which tends to urge the chips toward the outer edge, the file is said to possess self cleaning properties, and can be used on all metals including brass and aluminum or even marble. The file can be re-cut four times at very little cost, whereby an economy of 36 per cent is claimed over the ordinary file.

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RAILWAY MACHINERY

A SPECIAL EDITION OF MACHINERY FOR THE RAILWAY SHOP, DEVOTED TO LOCOMOTIVE AND CAR EQUIPMENT AND MECHANICS.

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We solicit communications from practical men on subjects pertaining to railway machine shop practice, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

MARCH, 1907.

THE HUDSON RIVER TUNNELS.

The Hudson Tunnel Companies, which are building an elaborate tunnel system of four bores under the Hudson River with connecting tunnels between Jersey City and Hoboken on the western side and an extension on Manhattan Island from Hudson Street to the new Pennsylvania tunnel at 32d Street, have made some predictions as to what the running time will be. It is promised that the trip under the river from the new tunnel station at Church and Cortlandt Streets to the Pennsylvania station in Jersey City, will require only three minutes, and to Newark, N. J., will require only twelve minutes more, or fifteen minutes in all from New York. The terminal structure at Church, Cortlandt and Fulton Streets, will be one of the wonders of lower New York. The building will be 22 stories high and the foundation will extend 75 feet below the surface to bed rock. The building of the foundation alone constituted a feat in engineering that is the greatest in foundation building that has been accomplished during the present era of high building operations in New York. The building will have 4,000 offices and it is expected to house 10,000 permanent occupants. The ground space covered is about 70,000 square feet. The downtown tunnel consists of two bores; the cars will come in on the Cortlandt Street side and discharge their passengers in the basement of the terminal building and pass out by a loop down Fulton Street and back across the river. On the Western side of the river there will be two tunnel bores, parallel with the Hudson and connecting with the D., L. & W. station at Hoboken. The old Hudson tunnel system first projected which is now nearly completed starts at 14th Street, Jersey City, and crosses to Hudson Street, New York. From Hudson Street the system extends northward along Sixth Avenue to the present site of the Pennsylvania tunnel at 32d and 33d Streets.

* * *

EXCESSIVE HOURS OF WORK FOR RAILROAD TRAINMEN.

It is almost impossible to understand that there can be any opposition whatever to the bill introduced by Senator La Follette of Wisconsin providing that railroad employes should not be permitted to be in actual service for more than 16 consecutive hours daily. It seems as if even this number of hours would constitute a dangerous maximum, and in view of the many railroad accidents that have been charged to the overworking of railroad employes this measure becomes a protection, not to the railroad employes themselves, but to the traveling public. There have been cases on record where railroad accidents have resulted from the engineman or the flagman having been kept on continuous duty for 17 to 20 hours with only a few hours rest. In one case it is stated that the engineman lost control of his train, resulting in a collision, having been on duty continuously for 42 hours. Things like this demand public action, inasmuch as the public is expected to entrust life and safety to the wide-awake alertness of the engineer and the signal men on the line. The railroad who is demanding or permitting that its employes work such excessive hours is directly responsible for every life lost on its line, and the men in charge, from the president down, who can do anything to prevent such outrageous conditions, each one is personally to blame for the constantly increasing number of accidents on American railroads. Whether the deplorable state of affairs that results in the killing of scores of people who are forced to entrust their lives to the railroads is due to corporate greed or to the incompetency of the managing officials is of little consequence to the public as long as the disastrous results are the same. If due to the former cause no protest can be too strong, no measure to stop this sacrificing too radical. If due to the latter, then the time has come for the public to demand the removal of financial parasites from the responsible positions, and the placing of practical railroad men at the head, at the same time as the railroads' patrons have a right to demand that the men upon whom their lives depend shall not be worked to such a degree that attention to exacting duties is impossible. Any legislative measure in this direction of checking existing abuses is to be commended. The present bill ought, by all means, to be enacted; it ought to be supported by all right thinking railroad men, and it ought to be enforced in the greatest possible degree.

* * *

MECHANICAL CRIMES IN REPAIR WORK.

To one who is thoroughly conversant with principles and practice of thorough-going repair work, the expression "mechanical crime" would perhaps be better recognized as "butchering work," that is, doing it in a slow, costly and unsatisfactory manner, but in whatever way it is expressed it means about the same thing. It is a melancholy fact that much repair work is done at an excessive cost to the owners. By this we mean that if it had been done by men who knew their business, the work would have been turned out equally as acceptable at a fraction of the price charged for it. When an inexperienced man—inexperienced in the sense of handling certain classes of work—tackles a piece of repair work he often finds himself "up against" a proposition that staggers him, and if he manages to wiggle out of it the proprietor pays the bill which includes the price of experience for both parties. For example, it is not uncommon to find a set of boiler tubes in the scrap heap which are nearly as good as new, but scrapped simply because when it was necessary to remove them from the boiler for repairs, they would, of course, be too short for replacement after cutting off the split ends. Now, the welding of short pieces known commonly as "safe ends" to boiler tubes is a practice followed in scores of railway shops and is recognized to be a perfectly sound and safe practice. In this way locomotive tubes are kept in service for many years, having perhaps been removed and replaced a dozen times before being burned out to a condition that causes their final rejection. To the railway mechanic or boilermaker the "safe-ending" of tubes is such a common and well-known practice that he is struck with wonder that such practice is an exception rather than the rule in the repair work of small stationary power plants.

In speaking of repair work it may be well to comment on the comparative standing of repair work and new construction. The genesis of things is the most interesting and profitable, of course, to the mechanical engineer who would aspire to be an originator and builder. But many have thought they could learn much and be better engineers after a course of training in our best railway repair shops. Repair work is an art in itself—it differs radically from manufacturing. The manufacturing shop cannot handle repair work profitably, neither can the repair shop manufacture profitably. It requires a different class of men—men, we may say, who are in some respects broader in judgment and quicker in the grasp of a situation. They may not be experts in handling a micrometer, or in laying out a design on the drawing board, or in doing work systematically as the manufacturing engineer must be, of course, but they do have a practical adaptability in getting the wheels going again at a minimum cost of time and labor, and this is what counts.

SYSTEMS AND RED TAPE.

It is exceedingly difficult to devise and adhere to a shop system without introducing a certain element of "red tape." A limited amount of red tape may not be objectionable. It simply impresses the importance of a systematic order of things. But when, as too often is the case, it goes so far that it seems that the system with all its red tape is the one important factor, and the thing systematized is of only secondary value, then is the time to find out whether so much of it is not "too much of a good thing." It happens, though we hope it does not happen in very many shops, that economy in production is sacrificed for adhering to the rules which cannot be changed without changing the system; and changing a system is by some office men looked upon as little short of sacrilege.

Let us by all means have systems, but let not the system become greater than the thing systematized, the economical production of the shop. Let not the part become greater than the whole. Make rules, but do not make them so hard and fast that they can under no circumstances be adapted to suit special requirements. And by all means, let us not be afraid to change the system, radically change it, if necessary, even if it involves a great temporary expense, provided that in the future it will contain less red tape and fill its purpose better. Finally, let us recognize that the system is not the end, but only a means to an end, and should remain in this station.

* * *

EFFECT OF VELOCITY ON THE FLOW OF PLASTIC METALS.

We recently had an interesting correspondence with one who was confronted by the question of whether the velocity with which the compression of a certain bronze piece was effected made any material difference in the pressure required. For example, take the case of a bronze cylinder 4¼ inches diameter, 4 inches long with a 2-inch axial hole; a test under a hydraulic press showed that a maximum pressure of 250 tons or nearly 23 tons per square inch sufficed to compress the cylinder to a length of 3½ inches, the velocity of the ram being 0.35 inch per minute. Now it is known that at below, say, 25 inches per minute, the rate of tension does not materially affect the ultimate stress required, and the same is supposed to apply in compression. In this case there was a condition of having greatly increased the velocity by the use of a heavy crank and knuckle-joint press, and the machine had broken down doing work for which it was recommended. The makers of the press claimed that the higher velocity at which the work was done (over 140 times the rate of the hydraulic press) imposed a much heavier pressure on the gate than that for which the machine was designed, hence it broke down under a pressure considerably greater than the guaranteed strength. The one on whom it devolved to make a comparative test in the interest of the owners and users of the press to show whether the failure was due to the high velocity or to weakness of the press, was not a technically trained engineer, but nevertheless he devised a simple apparatus which demonstrated conclusively that the higher velocity did not make a material difference in the pressure required to compress the bronze piece to the required degree. In making the test he supported the specimen on the middle of a heavy steel bar which in turn was supported at the ends, thus putting it in the condition of a beam supported at the ends and carrying a load at the center. The deflection of this steel beam was measured by a micrometer, while a specimen was compressed under a slowly moving hydraulic press, noting at the same time the pressure, in tons on the gage, required to effect the deformation. Then a similar specimen was compressed under a crank and knuckle-joint press, having a gate velocity of 50 inches per minute and the deflection of the steel bar was again measured for the same amount of compression of the specimen. It was found to be almost exactly the same, showing that for the velocity of compression mentioned it did not make any material change in the pressure required.

One reason for speaking of this matter is that, aside from the more or less important fact that velocity within the range indicated did not change the pressure required, here was a technically untrained mechanic who was required to make a test to ascertain a fact, but who was not provided with any apparatus save that which any ordinary shop provides. His method of making the tests might, in some details, be subject to criticism, but in the main they show exactly what he desired to show and served the purpose in most essential particulars. A trained engineer without that very necessary accompaniment, "horse sense," would very likely have required an expensive apparatus to have made his comparative tests, but they would have been little better than these, except that they perhaps would stand better in a case at law because of having recognized authority back of them.

* * *

WHO PAYS THE PRICE?

A Wall Street circular the other day contained the comforting information, based upon the calculations of what we suppose to be a Wall Street expert, that the royalties to be paid for the iron ore deposits leased by the United States Steel Corporation from James J. Hill will in 50 years amount to $1,190,000,000. This represents the earnings of an army of 26,000 men paid at the rate of $3 a day for a period of 50 years. The country is in other words to feed, clothe and house an army of 26,000 men for 50 years simply in order to pay Mr. Hill or his representatives for the permission to dig out the iron ore, and by the industry and ability of millions of men turn it into usefulness. We mention this simply as a matter of fact, and not because we find any fault with Mr. Hill or anyone else who simply takes advantage of long established customs. But what do we pay this enormous sum for? For any great benefit conferred upon the country by Mr. Hill? By no means. These ore deposits would have existed and been equally useful had their present owners never been born.

Who are to pay this royalty? All those who use steel, in the first place the railroads and machine builders of the country, secondly, all those who use railroads and machinery, and finally all who use the products of machinery. We do not call attention to this fact because we protest against it; that seems more or less useless. We simply recognize it as our duty to call attention to the reason why raw materials are increasing in price although the processes of obtaining them from nature's storehouse is constantly becoming cheapened and simplified. Our American manufacturers and machine builders pay the price of a monopoly, and this price is still further augmented by our fiscal system of preventing foreign steel to enter our market at a penalty of from 8 to 12 dollars a ton. This penalty is exacted in the name of protection to infant industries. In order to protect such tiny industries as those connected with our steel production, comprising one of the most gigantic and powerful corporations in the world, our other industries which are purely competitive, and who rely entirely upon skill, inventive ability and business capacity for their existence, must be curtailed and suffer. The retarding action is perhaps not so much in evidence in the machine tool business whose systematizing and standardizing have made it possible for the business to prosper in spite of adverse conditions in regard to high raw materials. But let us not be blind to what it has meant to our shipbuilding industry. First we kill off this enterprise by protecting an infant industry until no one will undertake to build ships here when they can be built by cheaper raw material so much more economically elsewhere. Then we think that we must subsidize our ship-building interests, thus affording a new opportunity for the steel business to exact the tribute incidental to lack of competition.

If there be any infant industries crying for protection, although we do not know of any, let us give them protection. But why should we advocate the continuation of protection to powerful monopolies who profit by their ability to demand tribute from competitive business enterprises? Let us remember that we all have prospered in the past because of our inventive ability and enterprising spirit, not because we have undertaken to foster monopolies. And we have great faith in the capability of American industries to prosper by the same means henceforth.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

Rates of duty on machinery and machine tools imposed by various countries have been compiled by the Bureau of Manufactures, Department of Commerce and Labor, and are published serially in the *Daily Consular and Trade Reports*, commencing February 1, 1907.

Iron sheets coated with aluminum are now being manufactured in considerable quantities, and have been found to be very durable under long exposure. These aluminum-coated sheets ("aluminumized" iron) will probably supplant galvanized iron for many purposes.—*Valve World.*

Monel metal is a recently patented nickel-copper alloy having remarkable strength, wearing quality and resistance to corrosion, especially the latter in the presence of hot gases. It has a tensile strength of about 95,000 pounds per square inch. It is composed of nickel, 75 per cent, copper, 23.5 per cent, and iron, 1.5 per cent. It is being used in the Knox automobile engine for the exhaust valves with marked success.

The interstate commerce commission is preparing to make an investigation into the rates charged by the express companies. Within a few weeks, hearings will be held at Washington and Chicago, and probably at New York and other points. It has been stated that complaints have been received from all parts of the country that the rates of express companies are excessive, and that, therefore, the commission will conduct practically a general investigation.

The number of locomotives built at the Baldwin Locomotive Works, Philadelphia, Pa., in the year 1906 was 2,652, comprising 201 electric and 2,451 steam. Of the 2,451 steam engines, 133 were equipped with compound cylinders. This represents the largest output of the Baldwin Locomotive Works in any year of its history. The number of men employed by the works, exclusive of the Standard Steel Works, at this time is about 19,000.—*Iron Age.*

At the present time, when platinum prices have reached a height making the use of the metal prohibitive in many instances where it would be desirable, the reports from New Zealand that platinum has been found in that country is demanding great attention. The analysis of certain proofs has given a limited amount of platinum, but it is expected that even richer ores may be found in the Pounamu district on account of the geological formation in this part of the islands.—*Industritidningen Norden.*

An interesting example of extreme human performance is that recently done in Paris by the victor in a peculiar race. One hundred and twenty contestants took part in a race up the 730 steps leading to the second stage of the Eiffel tower. The winner made the distance in three minutes and four seconds. Taking the weight of the winner as 150 pounds and the lift of each step as 8 inches, a simple calculation shows that for this period he exerted the almost incredible average of 0.71 horsepower.

According to the *Horseless Age* alcohol instead of gasoline was tried on a recent trip with a Dragon car, making a run between New York and Philadelphia. The result, however, was not quite as gratifying as one might wish for. About three times as much alcohol was used as would have been used of gasoline, and the power from the motor was not quite as great, but this of course was due to the fact that the compression was not high enough for alcohol, as the engine was not specially designed for the use of this fuel.

The Carnegie Institution, of Washington, D. C., has made a grant of $3,000 a year for a period of four years to Dean W. F. M. Goss, of Purdue University, Lafayette, Ind., for the purpose of determining the value of superheated steam in locomotive service. This is the second grant which the institution has made to Dr. Goss. While given to him personally, its effect will be to stimulate and to make more effective the work of the Purdue locomotive laboratory. The result of Dr. Goss's previous research under the auspices of the Carnegie Institution, which was for the purpose of determining the value of different steam pressures in locomotive service, is now in press.—*Railway Age.*

The requirements for the installation of a successful windmill electric plant are stated in a concise form by Mr. W. O. Horsnaill, England, as follows: Ascertain first the average daily load in ampere hours during the periods of maximum current consumption. Then provide a storage battery for a capacity at least double this output, install a dynamo of sufficient capacity to charge this battery for 12 hours, and lastly select a windmill sufficiently large to run the dynamo at full load with a 10-mile per hour wind. Fit the windmill and driving gear to the dynamo by ball or roller bearings throughout so as to, as far as possible, eliminate frictional loss.

A learned German professor has devoted considerable time to the measuring and calculating of the value of the electrical energy of a lightning. We are now comforted by the information that a lightning of a duration of 0.001 second and a length between the charged bodies of two-thirds mile represents an electrical energy corresponding to a commercial value in Berlin of 650 dollars. Now there is no more excuse for lack of power for manufacturing purposes in a country with so frequent thunderstorms as the United States, provided, of course, that our professor does not forget also to tell us how to get hold of the lightning.

The *Industrial Magazine* is devoting a short note to the tests now carried on at Charlottenburg, Germany, with the new "Osram" electric lamp. In this lamp the carbon filament for incandescent lamps is replaced by fine wires of wolfram, which are claimed to employ only one-third of the energy heretofore required. The tests show that after having been used 1,000 hours, there was an average loss of brilliancy of 6.3 per cent in the case of 25 candle power lamps, and 3.6 per cent in the 32 candle power lamps. The only drawback with this lamp is that it can be used only hanging downward, but the inventor expects to be able to overcome even this disadvantage.

The Department of Public Works in Prussia has called the attention of the railways to certain defects which have appeared in the locomotives furnished with superheaters, and has suggested means to remedy the defects. It has been found that in the steam boxes of the Schmidt superheater the projecting ends of the steam tubes rust easily, and rapidly weaken, with the result that the crown plates of the superheating chamber become distorted and leak. Drainage channels have been tried with valves opening into the steam box, and these valves open automatically by the action of spiral springs when the steam pressure is shut off. The effect of the drainage valves has also been to maintain the strength of the plates.—*Practical Engineer.*

A company has been formed at Prague for the manufacture of artificial rubber, called "Zackingummi," invented by a Swedish engineer. It is stated that the cost of this material is but a third of that of rubber, and that it has been used for various purposes, such as for filling motor car tires, to which it absolutely attaches itself, for packings, etc. It is stated that this material has the advantage of being unaffected by the atmosphere, and that it will not perish as does rubber. Tests on Zackingummi have been executed at the official testing station of the Stockholm Engineering College, which show

that it is many times stronger than rubber, while for use in connection with vacuum brakes the Swedish State Railways are said to prefer it.—*Times Engineering Supplement.*

The following additional information is of interest regarding the Poulsen wireless system of telegraphy which we mentioned in the February issue. Stations have been built in Denmark in which syntonization as close as one per cent has been attained; that is to say, a pair of stations can operate with wave lengths of 600 meters, and another pair in the same territory with waves of 606 meters, without interfering with each other. Waves having lengths of from 300 to 3,000 meters can be conveniently generated, so that several hundred stations may operate within the same sphere of influence, it is said. As more energy is generated with the longer wave lengths, these are used for the long-distance work, and they naturally go with the taller masts, while the short waves and lower masts are employed for the near-by signaling.

The *Times Engineering Supplement* gives some details regarding the successful experiments with wireless telephone between Berlin and Nauen, Germany, a distance of twenty-five miles. The messages were sent from Berlin to Nauen, and as a check on the accuracy of the signals an ordinary telephone wire was employed for return messages from Nauen to Berlin. After the attention of the Nauen operator had been secured by striking with a rod of metal on the metal mounting of the microphone, beginning with the customary "Hallo" a series of numbers were called out into the microphone. At first single numbers were repeated several times into the speaking trumpet attached to the microphone, and the numbers were called back from Nauen by means of the ordinary telephone. Next sets of figures were selected and these speedily came back correctly by the ordinary telephone. There were occasional interferences or interruptions which caused a suppression of whole groups of figures, but when these were repeated, correct results were obtained. Subsequent tests were made by calling numbers and letters both singly and in groups. Lastly the attempt was made to transmit an entire sentence and this was, on the whole, intelligently and correctly conveyed.

A very good and comprehensive way of expressing the advantages and disadvantages of various types of steam engines is given in *Power*, January, 1907, by W. M. Wilson. The types of engines taken into consideration are high speed and low speed reciprocating engines, Parsons steam turbines, De Laval turbines and engines with condensing plants. The advantages and disadvantages of each are stated as follows:

High-speed Engines.

Advantages.	Disadvantages.
Low initial cost of engine.	Large coal consumption.
Moderate cost of generator.	Large boiler capacity.
Cheap type of boilers.	
Moderate floor space.	

Low-speed Engines.

Advantages.	Disadvantages.
Low coal consumption.	High initial cost of engines.
Small boiler capacity.	Expensive type of boiler.
	Large floor space.

Parsons Turbines.

Advantages.	Disadvantages.
Moderate initial cost of turbine.	Expensive type of boiler.
Small floor space.	
Small boiler capacity.	
Low coal consumption.	

De Laval Turbines.

Advantages.	Disadvantages.
Moderate initial cost of turbine.	
Small floor space.	
Moderate boiler capacity.	
Moderate coal consumption.	
Cheap type of boiler.	

Engines with Condensing Plants.

Advantages.	Disadvantages.
Decreased coal consumption.	Initial cost of condenser.
Decreased boiler capacity.	Cost of condensing water.

CAST IRON MAGNETS.

Electrical Review, January 5, 1907.

Some time ago it was pointed out by Professor B. O. Peirce that chilled cast iron was an excellent substitute for the more expensive steel alloys generally used for making permanent magnets. He found that with a careful heating and chilling he could prepare magnets which while possibly not suitable for the finest measuring instruments, still served admirably for constructing less elaborate devices. These magnets had retentivity comparable with that of the more expensive steel magnets.

Investigations have also been carried out by Mr. Albert Campbell with a view to determine the value of such magnets. He heated cast iron to about 1,000 degrees Centigrade, and quenched it in water. Several of the cast iron magnets thus obtained gave better results than were secured from some steel magnets, although they were inferior to those made from another brand of magnet steel. While the experiments do not agree with one another closely, they show that excellent permanent magnets may be prepared from cast iron. For certain instruments, where constancy over a long period is not essential, cast iron will undoubtedly be satisfactory; but in many types of electrical measuring instruments it is very necessary that the magnet remain constant in strength for a long time. To secure this, careful treatment and seasoning is necessary, and it has not yet been shown that satisfactory results may be obtained from cast iron when the requirements are of this kind.

TIDAL MOVEMENT POWER STATION.

Engineering News.

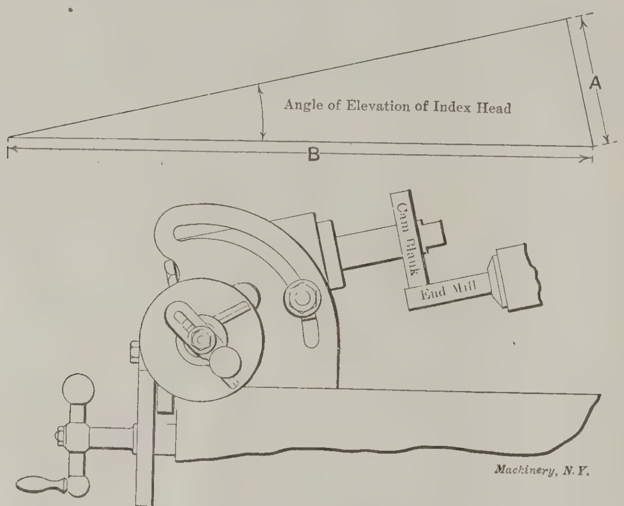
At various times there have been experiments made for using the enormous quantities of energy in the tidal movement of the ocean. So far experiments have had but little success, but a new attempt about to be made at Rockland on the coast of Maine seems to be more promising. An air-compressing plant will be installed and the power will be transmitted by pipe lines in the form of compressed air to the place where it is to be used. It is claimed that it is practical to arrange for storage chambers sufficiently large to store the air in order to cover that period of time at the flow and ebb tide when the compressors would either not work at all or else work at such low efficiencies as to be commercially impracticable. Contrary to the usually preconceived notions, it is practicable to transmit compressed air through pipes, long distances, with comparatively slight losses. It has been demonstrated by the Popp system, in Paris, that the leakage is very slight, and four years' experience, at Norwich, Conn., shows the same result. Hydraulically compressed air, being a perfectly dry gas, the frictional resistance, in good, smooth-coated pipe, is remarkably low, and velocities of 50 to 70 feet a second are admissible. The cost of pipe lines is not so greatly in excess of electrical transmission lines, when the cost of step up and step down transformers, etc., are taken into consideration. The scheme at Rockland having been financed, work will begin in the early spring on the construction of the dam and the laying of pipe lines to the quarries of the Rockland, Rockport Lime Co., to the power-house of the Rockland, Thomaston & Camden St. Ry., and to several cities in whose streets distribution mains will be laid the same as gas pipes. It is expected that the plant will be completed in the fall of 1907.

AN INGENIOUS WAY OF MILLING CAMS.

American Machinist, January 17, 1907.

Cams having regular rise may be milled, so to speak, automatically in the milling machine by placing the cam blank on the dividing head spindle and gearing the head for spiral milling, while an end mill is put into a vertical milling attachment of the type which is adjustable to any angle in the vertical plane, as shown in the cut. The end mill is of course placed at an angle with the table of the machine, this angle being determined by the rise of the cam and the forward feed of the milling machine table for one turn of the index head spindle. It is evident that when the table is feeding forward the cam blank moves along the cutting edge of the

end mill, and as this latter is stationary, the radius of the cam will be constantly diminished. The problem of finding the inclination at which to set the index head may be most easily explained by the diagram in the cut. In a right-angle triangle, as shown, the hypothenuse B represents the distance that the milling machine table is feeding forward while the index head spindle makes one complete revolution. The side A in the triangle represents the rise that the cam to be milled would have in one complete turn. If we now want to cut a cam having a rise of ⅛ inch in 300 degrees, then the rise in a complete turn will of course be to ⅛ in the same proportion as 360 is to 300, or in other words the rise for a complete turn equals $\frac{360}{300} \times \frac{1}{8} = 0.15$. This distance 0.15 inch is the side A in our diagram. Suppose that the slowest lead of the milling machine, or the amount that the table moves forward while the index spindle makes one complete turn is 0.67, then $\frac{0.15}{0.67} = 0.224$ must equal the sine for the angle to which to set the dividing head which in this case will be approximately 13 degrees. The milling machine with its end mill must of



Ingenious Way of Milling Cams.

course be set to the same angle as the dividing head if we wish the edge of the cam to be parallel with the shaft on which it is to be placed. When the diameter of the cam and the inclination of the head admits, it is advisable to mill on the under side of the cam, as that brings the milling cutter and table nearer together, and increases the rigidity, besides making it easier to see any lines that may be laid out on the flat face of the cam. At the same time the chips are prevented from accumulating on the work. In many cases it will of course be necessary to use mills of extra length in order to permit the cam blank to move the necessary distance along the cutting edge of the mill.

ALUMINUM WIRE FOR MAGNET WINDINGS.

Industritidningen Norden.

The natural oxide of aluminum forms so effective an insulation that magnet windings of uninsulated aluminum wire have proven feasible. The thin film of oxide on the wire will insulate it against a potential of 0.5 volt. As in the case of windings for direct current there usually is no more difference between the voltage in two adjacent coils than 0.06 volt, it is entirely possible to depend upon the insulation of the oxide alone. The different layers of the winding must, of course, be provided with some other means of insulation, because of the greater difference in voltage between these. Paper wound wet between the layers has proven effective for over 200 volts, and extra oxidation has been secured by dipping in a chemical bath for higher potentials. In most cases, however, an artificial oxidation is not necessary as the dampness of the air alone will produce the necessary amount. In the case of alternating current, the film of oxide is produced slower, and for this reason it is claimed to be of advantage to let a direct current go through the windings for some short time, say 15 minutes, after the winding is completed. An advantage with windings of this kind is that the film of oxide increases at the same time as the insulating material between the layers is losing its insulating qualities, but this increased oxidizing is not enough to in any way interfere with the conducting qualities of the aluminum wire. As no insulation is necessary, there is also a possibility of using the larger diameter of wire necessary on account of the smaller conductivity of aluminum without occupying any more space, and square wire has also been used to advantage, whereby space is saved to a great extent. Comparing the price of copper and aluminum, the former wire being insulated, there have been cases where the saving in expenses has amounted to from 25 to 50 per cent and the saving in weight from 50 to 60 per cent. The method is introduced by a German engineer, Hopfelt, and practical experiments seem to indicate that the new method will actually prove itself to have a great practical value. It seems, however, to be indicated by the experiments that magnets with windings of insulated aluminum wire are not feasible, or at least not advisable, for warm and very dry places, as dampness is the necessary condition for the production of the film of oxide.

UNIQUE EXPERIMENT IN TECHNICAL EDUCATION.

Iron Trade Review, December 27, 1906.

In this article Herman Schneider, dean of the College of Engineering of the University of Cincinnati, describes an unusually interesting plan which is being tried by that school, jointly with the various mechanical, electrical and chemical industries of the city in which it is located. The university is supported in part by direct taxation, so the authorities of the school have always felt that it was the duty of the institution to be of the utmost practical service to the community, rather than to concentrate its energies on the training of a few select scholars. With this idea in mind, the co-operative plan of teaching various branches of engineering has been undertaken. The students under this system work alternate weeks in the shops of the city and at the university, working in pairs, the two men of a pair alternating with each other at the shop and school. That is to say, during one week Mr. A is at the shop and Mr. B is at the school; the following week Mr. B is at the shop and Mr. A is at the school; Messrs. A and B both carry on the same work on the same machines in the shop, one taking up the work where the other leaves it. The course is six years in length, during which time all the subjects taught in the regular four years are given in an intensified form. Besides this each boy has served the regular apprenticeship course of every young man who intends to become a machinist.

It is to be distinctly understood that these students must have for entrance to the course all the educational preparation usually required, and that they receive as thorough a literary, scientific and mathematical training as is given in the best engineering courses. To make sure that the applicants for this training are of the right caliber, high school graduates are required to begin work in the shops in June, continuing their employment through the summer preceding their entrance into college. Thus, those who have not the necessary stamina are eliminated before the college work begins. It is found that most of the young men during this course are of the worthy class who desire to receive severe theoretical and practical training, and who also need to have the financial assistance which their pay as apprentices will give them.

The plan, so far as the university is concerned, went into effect last September. The class started with 30 young men who had been working all the past summer in the shops. About 45 began in June. Of these 15 were country boys, not one of whom has quit since he entered the shop. All the defections during the summer course were among the city boys.

Many doubts were expressed as to the practicability of this scheme. It was said, for instance, that the boy returning to the shop after a week's absence would be slightly impaired in skill on account of that absence, and that the students going to the university after a week's work in the shop would have

forgotten much of the work. These doubts have been dispelled. A careful canvass of the shops indicates that these men do as much work as, and in many cases more than, the regular apprentice. Most of the manufacturers have called them the best apprentices they have ever had. So far as the school work is concerned, the steadying influence of shop discipline seems to have a good effect.

Owing to the required obedience to commands in the shop, when the co-operative student is given a problem at the university, he goes to his desk and solves that problem by his own individual efforts. It is expected, also, that his shop service will have another advantage, in that the boy will learn a great deal about the mental attitude of the laborer to the employer, and about the position assumed by labor organizations toward the problem of production. Of this the four-year student is practically ignorant when he leaves college, and it has been the constant complaint of employers that college graduates are in no wise equipped to deal with that phase of shop management which concerns the employe. This regimen also seems to have had a good effect on the health of the students.

The strictly scholastic expenses amount to about $90 for the first year, $80 for the second year, and $60 for each subsequent year. The university has unfortunately no dormitory system, and students are required to find boarding places in the city, paying an average of about $4.50 per week. The wages paid by the manufacturers are not uniform. The lowest wage is $4.40 per week, increased at the rate of 60 cents per week for every six months until the course is finished, at which time the young man receives a bonus of $100. Some of the shops start their students at $1.00 per day, and in several cases shop owners are paying men for the week they are at the university. It is hoped that this question of remuneration will be standardized later. Within the last few weeks President Schneider has talked with every one of the 31 employers represented, and each one has asked him for a much larger number of these men next year.

Applications for entrance in the next year's class are constantly being received and the size of the class will depend solely on the number of men the shops and the university can take. It will probably be limited to 100 or 125 students. Applications amounting to one-fourth of this number have already been received, and it is probable that about 175 will be sent to the shops next June, of which 125 will probably begin the course next September.

THE GAS TURBINE PRACTICAL RESULTS WITH ACTUAL OPERATIVE MACHINE IN FRANCE.

Cassier's Magazine, January, 1907.

There has of late been a great deal of discussion regarding the possibilities of producing a practical turbine by the action of gases of combustion, but the whole subject has, with few exceptions, been treated as a matter entirely in the future. It will therefore be new to many to learn that an effective gas turbine has been in successful operation in the laboratories of the Société des Turbomoteurs, Saint Denis, France, and experiments are now conducted with this machine, not with the purpose of finding out whether it will actually work, but whether it will prove to possess a commercial mechanical efficiency.

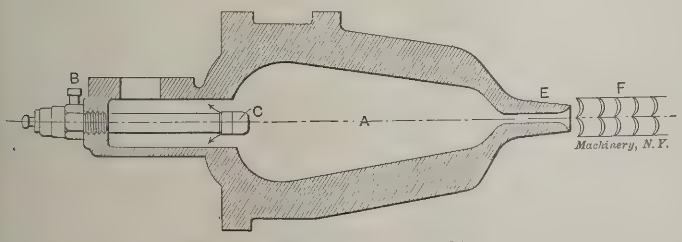


Fig. 1. Action of the Gas Turbine.

A successful gas turbine must combine the advantages of the gas engine, including the elimination of the steam boiler, with the advantages of the steam turbine, most important of which are simplicity of construction, lightness and continuous motion in one direction. Three plans have been considered for the design of gas turbines, that is, the hot air turbines, the explosion turbines and the combustion turbines. The first of these groups, the hot air turbines are not considered to offer any real advantages; at least, investigations in this direction have not as yet yielded any practical results. In the second group, the explosion turbines, the high velocity of discharge of the gases and the variations in the pressure render it impracticable to realize more than a small fraction of energy of the jet upon the wheel. The combustion turbine is thus the form most important to seriously consider. This machine consists in principle of the combustion chamber *A*, as shown in Fig. 1, supplied by a continuous current of compressed air and also by a continuous supply of liquid fuel (gasoline, petroleum, or the like) under pressure through a tube *B*, the mixture being ignited, when entering, by a platinum wire *C*, the combustion developing a constant temperature of about 3,200 degrees F. in the chamber *A*. The fluid products of combustion are then continuously discharged through a nozzle *E* upon the buckets of the turbine wheel *F*.

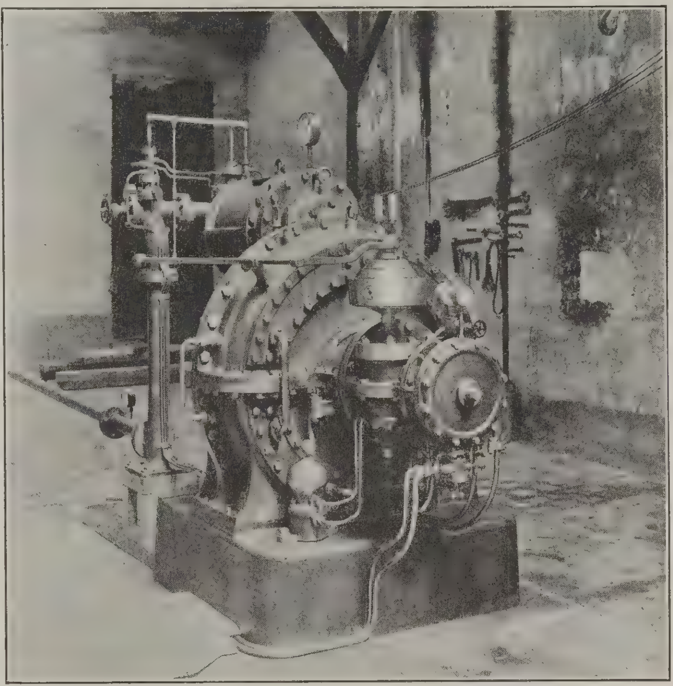


Fig. 2. Gas Turbine built by Societe des Turbomoteurs, Saint Denis, France.

The practical difficulties to be overcome in a combustion turbine may be summed up as follows: A gaseous fluid moving at high velocity must be kept constantly ignited by a device which must not be affected by high temperatures; the mixture of the combustible and the air must be made as perfect as possible; and the injurious action of the gaseous products at a high temperature upon the parts of the turbine wheel must be prevented. A machine complying with these conditions known as the Armengaud-Lemale turbine has been in successful operation for three years in the shops of the company previously mentioned. The first machine was made from a De Laval steam turbine of 25 horsepower arranged to be operated with combustion gases instead of steam. This arrangement was necessarily crude and not proportioned in such a manner as to give the best results. It enabled, however, the conditions essential for good efficiency to be determined. This efficiency depends greatly upon the pressure and temperature of the exhaust gases. In order to obtain the best efficiency, therefore, it is necessary to prevent the cooling of the gases before expansion, for instance, by introducing steam into the combustion chamber. The difficulties accompanying high temperatures may be overcome in the case of the combustion chamber and other fixed parts by the use of a water jacket and by the employment of a refractory lining. The real difficulties are met with in trying to provide for the effect of the highly heated fluid upon the turbine wheel itself. The most practical way of keeping this wheel cool is to follow the jet of hot gases by another jet of a low temperature so that the buckets of the wheel pass successively through alter-

nately hot and cool zones. The low temperature jet found most practicable is that of low pressure steam.

The machine built as a result of the experiment with the De Laval turbine is shown in the halftone Fig. 2. It is of the same general type as the Curtis steam turbine, and is capable of delivering from 400 to 800 horsepower, according to the capacity of the compressor utilized. The turbine is operated at 4,000 revolutions per minute, the speed regulation being effected by a throttling valve in the air admission pipe for small speed variations, and by a change in the fuel supply for larger variations. The turbine wheel is arranged to be cooled internally by water circulation in such a manner that the water, being supplied by radial passages from a hub of the wheel, enters into circular channels in the body of the rim, and from there passages permit the water to enter into each blade of the turbine; the difference in specific gravity between the hot and cold water is found to make an automatic circulation in connection with the centrifugal force due to the high velocity of rotation.

KEYS AND KEYWAYS.

Zeitschrift des Vereines deutscher Ingenieure.

It is not very common in practice to determine the dimensions of keys by calculation, but rather according to the results of experience, so that great differences between the sizes used by different machine builders are not uncommon. Twenty years ago, however, a collection was made of the various key standards, and a system of average dimensions was founded on this basis. These dimensions, having stood the test of time, can be utilized as a basis for the examination of the strain to which keys are exposed. If we assume that the narrow side of the key alone has to take up the moment of rotation then the strain of these narrow sides must be about the same as the strain of the material in the shaft itself. The narrow sides are subjected to the specific superficial pressure p, while the tension k in a shaft of the diameter d is produced by the moment of rotation M. (See Fig. 1.) The lateral surface pressure Q on the key is therefore

$$Q = \frac{M}{\frac{d}{2}} = \frac{\pi}{8} d^2 k = 0.4\, d^2 k \text{ (approximately).} \qquad (1)$$

This pressure has to be taken up by half the narrow side of the key and therefore

$$0.4 d^2 k = \frac{h}{2} lp \qquad (2)$$

The length l of the key is usually about 1 or $1\frac{1}{2}d$, the value $l = d$ being the average minimum. The superficial pressure p should not be allowed to exceed 17,000 pounds per square inch. The strain of rotation k should be taken at a lower value than in the case of shafts exposed to a pure twisting strain, since keyed shafts are almost invariably subjected to a high bending strain at the same time by the pull of belting, the pressure of wheel teeth, etc. Consequently k may be taken from 2,800 to 5,600 pounds per square inch or an average of 4,200 pounds to the square inch.

By substituting the values $k = 4{,}200$, $p = 17{,}000$, and $l = d$ in equation (2) we have approximately $h = 0.2d$. The key should therefore be sunk into the shaft and hub to a depth equal to 1/10 of the shaft diameter in each case, the depth being measured at the side of the key and not at the center.

The ordinary key offers a resistance to twist on the broad and narrow sides, the manner in which the strain is distributed between them being illustrated in Fig. 2. When the hub and shaft undergo a relative displacement through the angle w, the point A_1 on the narrow side moves toward A_2 and the point B_1 on the broad side toward point B_2. This results in a compression of the material to an extent indicated by a on the narrow side and by b on the broad side, the latter distance being about 1/6 of the former. The resistance to twist about the actual grooved surface for an equal strain on the material is proportionate to these two distances calculated on the relative dimensions of the two effective surfaces of the groove. For medium key dimensions this proportion is about 1 to $3\frac{1}{2}$, or in other words, the narrow sides are exposed to more than three times the twist of the broad sides. A key of the usual form, that is, slightly tapered and driven in place, takes up little or no strain on its narrow sides until the twisting force comes into play, but a very slight twist between the hub and shaft resulting from slight changes in form in the broad sides will bring the narrow sides into action. Whether the changes formed on the broad side exceed the elastic limit depends entirely on the care with which the groove has been cut and the key fitted. For these reasons the desire to secure both radial and tagential tension in one and the same key has led to the form shown in Fig. 3. Such a key would not be very difficult to make, the slots being given a considerable radial taper.

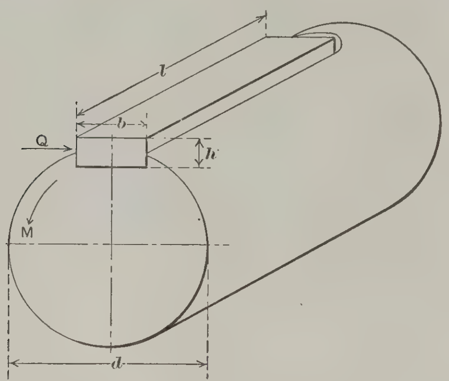


Fig. 1. Shaft with Ordinary Rectangular Key.

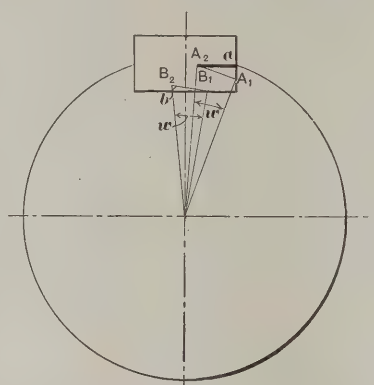


Fig. 2. Diagram of Forces Acting on Key.

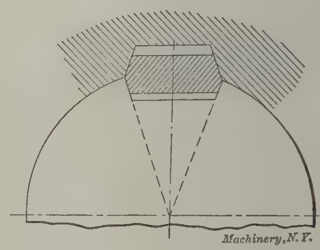


Fig. 3. Proposed Form of Key Equalizing the Radial and Tangential Tension.

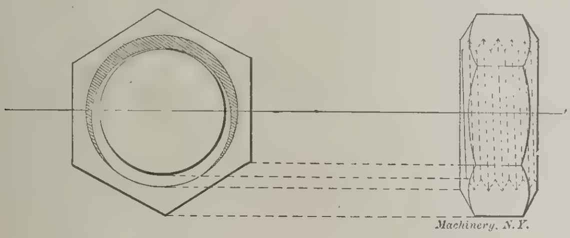
AN IMPROVED FORM OF LOCK NUT.

M. Andre Minne, in *Memoires des Ingenieure Civils*, July, 1906.

The trouble, inconvenience and expense due to the loosening of nuts are well known. A great number of remedies have been and are still daily proposed, many of which are very ingenious, but too complicated to be of everyday use. The most simple and most widely used are the ordinary check nut, the cotter pin, and the lock washer. These devices have incontestibly given good service, but they are nevertheless not sufficient to meet the requirements in a great number of cases. This is because, in a word, they do not attack the real cause of the loosening of the nuts. The cause of this loosening resides entirely in the mass of the nut, or rather in its inertia. It frequently happens that the complex vibrations to which the parts of a machine are subjected produce on the bolts which hold them together resultant forces, or rather couples, in a direction which tends to loosen the nut. We have in some cases, on machinery running at high speed, seen nuts leave their seat and continue under the impulse of the vibrations to climb up for a considerable distance on the threaded stem of the bolt. It is evident that the movement of these free nuts on their bolts could have been acquired only by the action of the couples just described on the mass of which they are composed. It can be easily shown by simple calculation that the force tending to loosening the nut under these conditions is directly proportional to the height of the nut, while it varies with the fourth power of the exterior diameter.

If one examines the very principle of the check nut, which is based on the cramping of its lower thread with the upper thread of the nut, this being the truly original and ingenious point in the device, it must be recognized that the form given to it does not allow more than a small useful effect in this direction. The whole lower surface of the nut inscribed in the hexagon being entirely in contact with the upper face of the main nut, the force is spread entirely over that surface, only a very small portion being utilized to produce the cornering or cramping of the threads on the screw; while all the surplus produces a harmful adherence of the faces in contact, rendering the nuts solid and permitting them to loosen simultaneously, the one carrying the other with it. Another effect of the simultaneous use of the two nuts has been often recognized but wrongly interpreted. Tightening of the check nut on the nut overcomes the reaction of the threads of this latter on those of the bolt and finally, if enough pressure is exerted, pushes the nut back toward the bearing on which it is seated, thus "unsticking," so to speak, the threads of the nut from those of the bolt. Thus the lower of the two nuts becomes useless and may be considered as free on its thread, so that the normal reaction of tightening, augmented by that created in screwing up the check nut, finally reacts on the threads of the latter which then becomes the true nut. That is why certain constructors have thought it best to give the check nut a thickness greater than that of the main nut.

Thus the principle of the check nut has been misconstrued, and this is why it is often found unsafe. It has even been the custom to provide it with a cotter pin, this being simply placed in a hole drilled above the nut or applied according to different systems, such as the "crown" or "castle" nut. It has then the fault of making accuracy in tightening impossible, and of being costly from the necessity for drilling the hole; it is difficult to put in place and remove, is often sheared by the vibrations and sometimes split, broken or rusted in its seat; in a word it is as inconvenient as it is unsafe.



Improved Lock Nut.

The lock washer is another device which has been used in many different ways and which possesses the good qualities of simplicity, ease of application and cheapness. The criticism to be made of it is that it destroys the accuracy of the nut, for it imposes an eccentric strain determined by the elasticity of the steel helix of which it is formed. It also destroys the flat bearing surface of the nut, which it is usually found necessary to increase by furnishing it with an ordinary washer. Thus the lock washer of the "Glover" or other design is seldom employed in accurate mechanical work, owing to the roughing of the bearing and the oblique strain on the bolt as just described. Its chief application, due largely to its low net cost, has been to the fastenings of fish plates on railroads, where it must be admitted that it has given very good service, although for more accurate work in locomotive practice it has been judged unsafe, most of the railroads having preferred to use the simple check nut.

It is then to the check nut that we return after investigating all these different systems, none of which give simultaneously the advantages of simplicity, ease of application and security In order to give the check nut a real efficiency we have only to remedy its signal faults. This is what has been done in the check nut which we are about to describe. Its efficiency is based on the two following principles:

First, the contact between the check nut and the nut has been reduced to a section of screw thread of the nut perpendicular to its axis, so that the tightening, taking place only on the threads, "corners" them perfectly within the thread of the bolt without producing a harmful adherence between the faces of the nuts which are presented to each other. This design, at the same time, does away with a necessity for any great pressure on the check nut due to the reaction of severe tightening, it being screwed up enough to prevent unseating, by the means just described.

Second, the diameter of the check nut has been reduced so that the energy imparted by the vibrations would be much less for it than for the main nut, which tends thus, in loosening, to still more increase the tightening of the threads in contact.

A check nut constructed on these principles looks like the accompanying cut, which shows in the cross hatched portion of the plan view, the surface which is in contact with the main nut, reduced, as before explained, to a perpendicular section of the thread of the screw. The theoretical conclusions just described have been fully confirmed by the different trials of this idea which have been made since 1903 on rolling stock and tracks of different railroad companies and street railways, on automobiles, and in general on all machinery subjected to great vibrations, whose nuts have hitherto given trouble by frequent slipping. This has been definitely stopped by check nuts of this type. Among the numerous applications of this system made in railroad service in the last four years the most important that can be referred to and those which have given the most characteristic results are:

First, its use on the rolling stock and locomotive equipment of the French State railways. The first trial was made on the cross bracing of the guard plates on an American locomotive, whose nuts were previously subject to frequent loosening. The trial lasted a year and was followed by the use of a hundred of these parts, after which the system was adopted in a general manner for this service, the purchasing agent having been required in all recent orders to use check nuts of this type in replacing ordinary check nuts, especially those on the suspension bolts of locomotives, tenders, and cars.

Second, on the road bed. The Metropolitan R. R., Paris, made a preliminary trial of 500 pieces on its fish plate bolts, then several thousands of check nuts were tried on difficult points. Finally the company adopted this nut for general use on all fish plates, track equipment, and the leverage systems of the electric signals. It seems certain that this type of check nut meets all the conditions of the problem which has just been described. That is, it locks the nuts by a simple and inexpensive method which is able to adapt itself to any bolt already in place, is easy to apply or remove, allows the amount of tightening to be easily regulated, and takes up the play of the parts concerned, giving, finally, entire security.

FRICTION AND LUBRICATION.

The Mechanical Engineer, September 1, 1906.

Probably the most important and complete series of experiments on the friction of journals and pivot bearings yet undertaken, was carried out by the late Mr. Beauchamp Tower, for a Research Committee of the British Institution of Mechanical Engineers. In carrying out the experiments, as the result of an accidental discovery, an attempt was made to measure the pressure at different points of the bearing. A hole had been drilled through the cap and brass for an ordinary lubricator, when, on restarting the machine, oil was found to rise through the hole, flowing over the top of the cap. The hole was then stopped with a wooden plug, but this was gradually forced out on account of the great pressure to which the oil was subjected, and which on screwing a pressure gage into the hole was found to exceed 200 pounds per square inch, although the mean load on the journal was only 100 pounds per square inch. Mr. Tower proved by this and subsequent experiments that the brass was actually floating on the film of oil existing between the shafting and the bearing. By drilling a number of small holes at different points in the brass, and connecting each one of them during the test to a pressure gage, Mr. Tower was able to obtain a diagram showing the distribution of pressure upon the bearing. It appears that the pressure is greatest a little to the off-side and at the middle of the length of the bearing, gradually falling to zero at each edge. The total upward pressure

was found to be practically the same as the total load on the bearing, again showing that the whole of the weight was borne by the film of oil. Any arrangement which would permit the film to escape was found to result in undue heating, and the bearing would finally seize at a very moderate load. The oil bath lubrication was found to be the most perfect system of lubrication possible. In the table below the results obtained by Mr. Tower are specified for three different methods of oiling.

	Actual Load in pounds per square inch.	Coefficient of Friction.	Relative Friction.
Oil bath	263	0.00139	1.00
Syphon lubricator	252	0.00980	7.06
Pad under journal....	272	0.00900	6.48

With the needle lubricator and a straight groove in the middle of the brass for distributing the oil, the bearing would not run cool when loaded with only 100 pounds per square inch, and no oil would pass down from the lubricator. The groove, in fact, was found to be a most effective method of collecting and removing the film of oil. In the next place, the arrangement of grooves usual in locomotive axle boxes was adopted, the oil being introduced through two holes, one near each end and each communicating with a curved groove. This bearing refused to take the oil, and could not be made to run cool, and after several trials the best results which could be obtained led to the seizure of the brass under a load of only 200 pounds per square inch. These experiments proved clearly the futility of attempting to introduce the lubricant at that part of the bearing. A pad placed in a box full of oil was therefore fixed below the journal, so as to be always in contact with it when revolving. A pressure of 550 pounds per square inch could then be carried without seizing, or very nearly the same load as in the case of oil-bath lubrication.

Results of Tower's Experiments.

One important result was to show that friction is nearly constant under all loads within ordinary limits, and that it does not increase in direct proportion to the load according to the ordinary laws of friction. This is indicated by the result of the experiments recorded below.

Journal, 4 inches diameter, 6 inches long. Brass, 4 inches wide. Speed, 300 revolutions = 314 feet per minute. Temperature, 90 degrees F.

BATH OF LARD OIL.

Pressure in pounds per sq. inch of bearing $p = \dfrac{W}{d \times l}$

Pressure per sq. in.	Coefficient of Friction $= \mu$	Product $p \times \mu$
520	0.0013	0.676
415	0.0016	0.664
310	0.0022	0.682
205	0.0031	0.635
153	0.0041	0.627
100	0.0067	0.670

BATH OF OLIVE OIL.

Pressure in pounds per sq. inch of bearing $p = \dfrac{W}{d \times l}$

Pressure per sq. in.	Coefficient of Friction $= \mu$	Product $p \times \mu$
520	0.0013	0 676
468	0.0015	0.702
415	0.0017	0.705
363	0.0019	0.689
310	0.0021	0.651
258	0.0025	0.645
205	0.0030	0.615
153	0.0044	0.673
100	0.0069	0.690

The coefficient of friction with bath lubrication varies inversely as the pressure, or, in other words, the friction of the bearing is altogether independent of the pressure upon it; the first law of friction should therefore read: "Temperature and velocity remaining constant, the friction coefficient is proportional to the nominal pressure, and the work done against friction is independent of the load, provided this does not exceed from 400 pounds to 600 pounds per square inch." From this it follows that the work done in overcoming friction is independent of the load upon a machine, and that there is no appreciable increase in the loss due to friction from no load to full load. Under a load of 300 pounds per square inch and with a surface speed of 300 feet per minute, Mr. Tower found the coefficient of friction to be 0.0016 for oil-bath lubrication, and 0.0097 for a pad.

In the next place it was found that the coefficient of friction is inversely proportional to the temperature, other conditions remaining the same, as shown below.

Variation of Friction with Temperature.—Journal, 4 inches diameter, 6 inches long. Brass, 4 inches wide. Speed, 300 revolutions = 314 feet per minute. Load, 100 pounds per square inch on nominal area.

BATH OF LARD OIL.

Temperature Deg. F.	(Degs. F. − 32) = t.	Coefficient of Friction = μ.	Product $t \times \mu$.
120	88	0.0044	0.387
110	78	0.0050	0.390
100	68	0.0058	0.394
90	58	0.0069	0.400
80	48	0.0083	0.398
70	38	0.0103	0.391
60	28	0.0130	0.364

The second law of friction should therefore be stated: "Nominal pressure and velocity remaining constant, the coefficient and therefore the work done against friction, is inversely proportional to the temperature of the bearing."

This has also been very neatly demonstrated by a recent experimenter, Mr. Dettmar, whose machine is electrically driven, and therefore the consumption of current could be very accurately measured during a five hours' run at constant speed and voltage. As load and velocity remain constant throughout the test, a decrease in the loss due to friction could only occur with a diminution in the coefficient. The current fell off exactly in the same ratio as the temperature increased, and as soon as the temperature became constant the consumption of current also remained constant.

The results of Tower's experiments seem to indicate that friction increases with the velocity, although not nearly in proportion to the square of the velocity as observed by Dettmar. As the result of the more exact determination possible with his machine, Dettmar found that friction increases very nearly as the 1.5th power of the velocity.

The mean values of the coefficient of friction for different lubricants, and with different methods of lubrication as obtained by Mr. Tower, are given in the following table:

Journal, 4 inches diameter, 6 inches long. Brass, 4 inches wide. Speed, 300 revolutions = 314 feet per minute. Temperature, 90 degrees F.

Lubricant.	Coefficient of Friction.	Max. Safe Pressure in pounds per sq inch on Nominal Area.
Olive oil	0.00172	520
Lard oil	0.00172	570
Sperm oil	0.00208	570
Mineral oil	0.00176	625
Mineral grease	0.00233	625

* * *

An important announcement has been made regarding the age limit of employes of the Pennsylvania Railroad. Some years ago under the management of A. J. Cassatt a pension system was adopted and the age limit at which men could enter the employ of the company was fixed at 35 years. The newly elected president, Mr. James McCrea, has decided to change the age limit from 35 to 40 years and will ask the directors to approve of the change at the annual meeting in March. The age limit of 35 years was copied by many other railroads and large corporations throughout the country, but during the past few years it has been found a mistake and a number of corporations have changed to the 40-year limit, including the Boston & Maine, Chicago, Milwaukee & St. Paul, and others.

* * *

An advertisement in a contemporary reads: "General Engineer and Electrician, with a thorough knowledge of steam engines and boilers, gas, oil and petrol engines, motor car, and launch construction, electric light and motor installations, wiring, repairing and testing, printing and bookbinding machinery, wood working machines, refrigerating plant, etc., also a very fair patternmaker and draftsman, inventor and patentee, desires situation."

ON THE ART OF CUTTING METALS.—3.*

FRED. W TAYLOR.

PROPER SHAPE FOR STANDARD SHOP TOOLS.

As stated in the beginning of this paper, our principal object in carrying on the investigation has been to obtain the knowledge required in fixing daily a definite task, with a time limit, for each machinist. It is evident that this involves the use of standard cutting tools throughout the shop which are in all respects exact duplicates of one another.

In our practical experience in managing shops we have found it no easy matter to maintain at all times an ample supply of cutting tools ready for immediate use by each machinist, treated and ground so as to be uniform in quality and shape; and the greater the variety in the shape and size of the tools, the greater becomes the difficulty of keeping always ready a sufficient supply of uniform tools. Our whole experience, therefore, points to the necessity of adopting as small a number of standard shapes and sizes of tools as practicable. It is far better for a machine shop to err upon the side of having too little variety in the shape of its tools rather than on that of having too many shapes.

Standard Tools Illustrated.

In the cuts Figs. 10 to 21, inclusive, are illustrated the shapes of the standard tools which we have adopted, and in justification of our selection the writer would state that these tools have been in practical use in several shops both large and small through a term of years, and are giving general, all-round satisfaction. It is a matter of interest also to note that in several instances changes were introduced in the design of these tools at the request of some one foreman or superintendent, and after a trial on a large scale in the shop of the suggested improvements, the standards as illustrated above were again returned to. These shapes may be said, therefore, to have stood the test of extended practical use on a great variety of work.

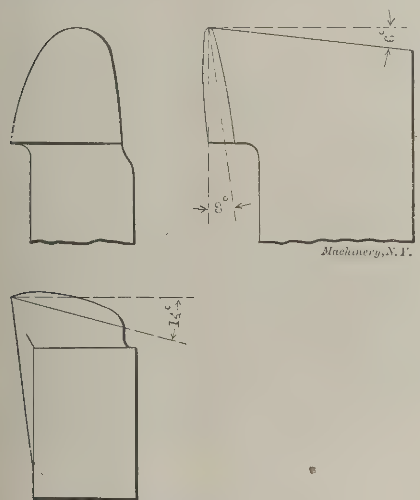


Fig. 10. Tool for Cutting Cast Iron and Hard Steel.

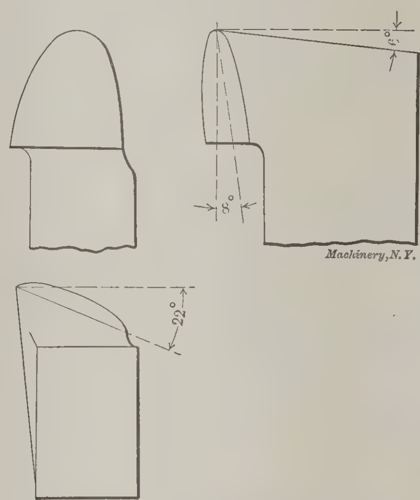


Fig. 11. Tool for Cutting Medium and Soft Steel.

Conflict between the Objects to be Attained in Cutting Metal.

Our standard tools may be said to represent a compromise in which each one of the following elements has received most careful consideration, and has had its due influence in the design of the tool; and it can also be said that hardly a single element in the tools is such as would be adopted if no other element required consideration. The following, broadly speaking, are the four objects to be kept in mind in the design of a standard tool:

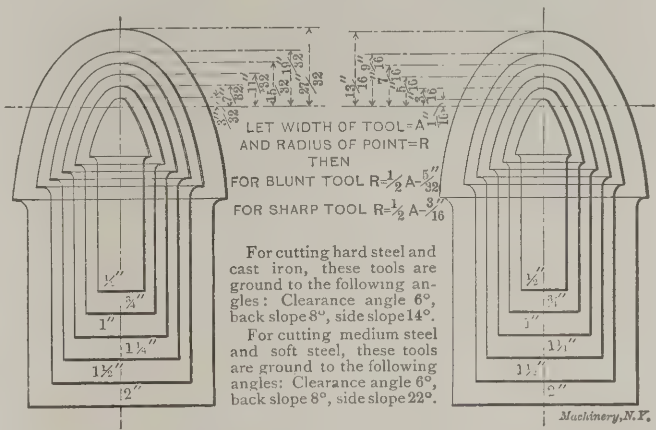
a. The necessity of leaving the forging or casting to be cut with a true and sufficiently smooth surface;

b. The removal of the metal in the shortest time;

c. The adoption of that shape of tool which shall do the largest amount of work with the minimum combined cost of grinding, forging and tool steel;

d. The ready adaptability to a large variety of work.

As we go further into this subject, the nature of the conflict between these four objects and of the sacrifice which each element is called upon to make by one of the others will become apparent. Generally speaking, we have been obliged to adopt as our standard shape a tool which can be run at only about, say, five-eighths of the cutting speed which our knowledge of the art and our experiments show us could be obtained through another tool of entirely different shape, if no other element than that of cutting speed required consideration. We have been obliged to sacrifice cutting speed to securing smaller liability to chatter; a truer finish; a greater all-round convenience for the operator in using the tool, and a comparatively cheaper dressing and grinding. The most important of the above considerations, however, is the freedom from chatter.



Figs. 12 and 13. Outline of Cutting Edge of Standard Round-nosed Tools.

On the other hand we have been obliged to adopt a rather more elaborate and expensive method of dressing the tools than is usual, in order to provide a shape of tool which allows it to be ground a great many times without redressing, and also in order to make a single Taylor-White heat treatment of the tool last longer than it otherwise would. And again, the shape of the curve of the cutting edge of the tool which we have adopted—first, to insure against chatter, and second, for all-round adaptability in the lathe—calls for much more expense and care in the grinding than would be necessary if a more simple shape were used. This necessitates in a shop either a specially trained man to grind the tool by hand to the required templets and angles, or preferably the use of an automatic tool grinder.

Relative Importance of the Elements Affecting the Cutting Speed.

The cutting speed of a tool is directly dependent upon the following elements. The order in which the elements are given indicates their relative effect in modifying the cutting speed, and in order to compare them, we have written in each case figures which represent, broadly speaking, the ratio between the lower and higher limits of speed as affected by each element.

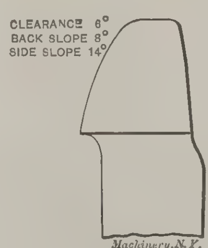


Fig. 14. Standard Tool for Wide Feeds.

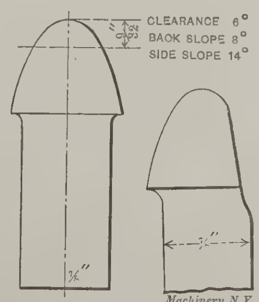


Fig. 15. Tool used in most of the Taylor Experiments.

A. The quality of the metal which is to be cut, *i.e.*, its hardness or other qualities which affect the cutting speed. Pro-

* Abstract of paper presented before the American Society of Mechanical Engineers, December, 1906.

portion is as 1 in the case of semi-hardened steel or chilled iron to 100 in the case of very soft low-carbon steel.

B. The chemical composition of the steel from which the tool is made, and the heat treatment of the tool. Proportion is as 1 in tools made from tempered carbon steel to 7 in the best high-speed tools.

C. The thickness of the shaving; or, the thickness of the spiral strip or band of metal which is to be removed by the tool, measured while the metal retains its original density; not the thickness of the actual shaving, the metal of which has become partly disintegrated. Proportion is as 1 with thickness of shaving 3-16 of an inch to 3½ with thickness of shaving 1-64 of an inch.

D. The shape or contour of the cutting edge of the tool, chiefly because of the effect which it has upon the thickness of the shaving. Proportion is as 1 in a thread tool to 6 in a broad-nosed cutting tool.

E. Whether a copious stream of water or other cooling medium is used on the tool. Proportion is as 1 for tool running dry to 1.41 for tool cooled by a copious stream of water.

F. The depth of the cut; or, one-half of the amount by which the forging or casting is being reduced in diameter in turning. Proportion is as 1 with ½ inch depth of cut to 1.36 with ⅛ inch depth of cut.

G. The duration of the cut; *i.e.*, the time which a tool must last under pressure of the shaving without being reground. Proportion is as 1 when tool is to be ground every 1½ hour to 1.207 when tool is to be ground every 20 minutes.

H. The lip and clearance angles of the tool. Proportion is as 1 with lip angle of 68 degrees to 1.023 with lip angle of 61 degrees.

J. The elasticity of the work and of the tool on account of producing chatter. Proportion is as 1 with tool chattering to 1.15 with tool running smoothly.

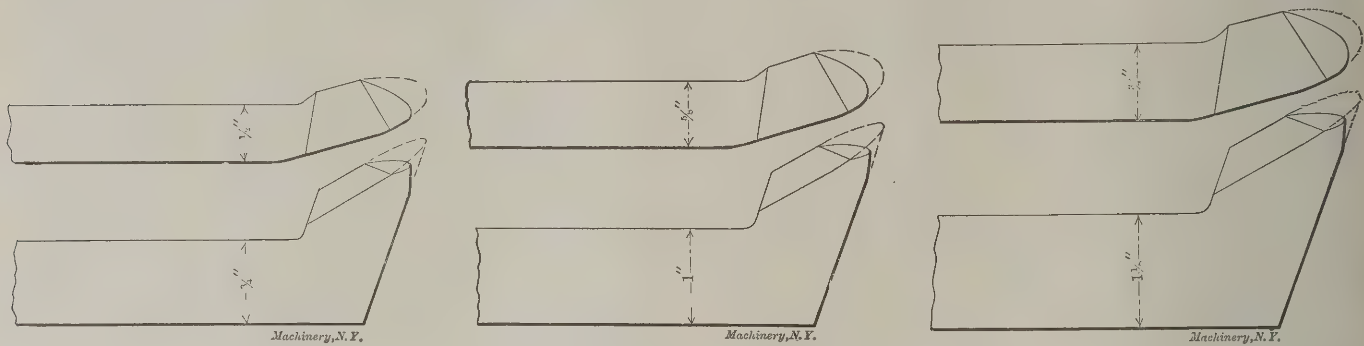
The quality of the metal which is to be cut is, generally speaking, beyond the control of those who are in charge of the machine shop, and, in fact, in most cases the choice of the hardness of metals to be used in forgings or castings will hinge upon other considerations which are of greater importance than the cost of machining them. The chemical composition of the steel from which the tool is made and the heat treatment of the tool will, of course, receive the most careful consideration in the adoption of a standard tool. No shop, however, can now afford to use other than the "high-speed tools," and there are so many makes of good tool steels, which, after being forced into tools and heated to the melting point according to the Taylor-White process, will run at about the same high cutting speeds, that it is of comparatively small moment which particular make of high-speed steels is adopted.

Advantages of Round-nosed Tools.

With round-nose tools, as the depth of cut becomes more shallow, there is a greater increase in the cutting speed than in the case of tools having straight-line cutting edges, because with a round-nosed tool the thickness of the shaving becomes thinner and thinner as the extreme nose of the tool is approached. In the case of round-nosed tools, therefore, when the depth of the cut is diminished, the cutting speed is increased for two entirely different reasons:

A. Because the chip bears upon a smaller portion of the cutting edge of the tool.

B. Because the average thickness of the chip which is being removed is thinner in the case of round-nosed tools with a shallow depth of cut than it is with the deeper cuts.



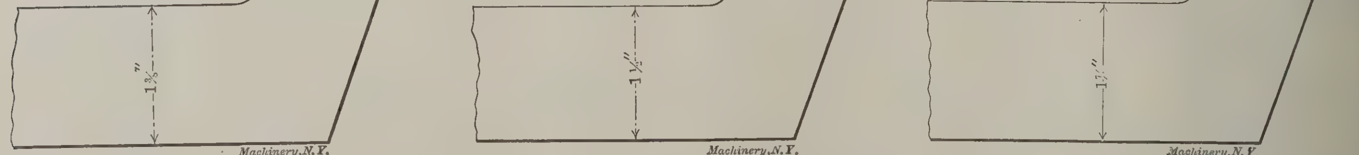
Figs. 16, 17 and 18. Standard Sizes of Tools.

Object of having the Cutting Edge of Tools Curved.

A tool whose cutting edge forms a curved line of necessity removes a shaving which varies in its thickness at all parts. The only type of tool which can remove a shaving of uniform thickness is one with a straight-line cutting edge. The object in having the line of the cutting edge of a roughing tool curved as that part of the cutting edge which does the finishing is approached, is to thin down the shaving at this point to such an extent as will insure the finishing part of the tool remaining sharp and uninjured even though the main portion of the cutting edge may have been ruined through overheating or from some other cause.

Advantages and Disadvantages of Broad-nosed Tools.

Upon appreciating the increase in the cutting speed obtained through thinning down the shaving, as shown in our experiments with straight cutting edge tools, the tools shown in Figs. 22, 23 and 25 were made, and used on roughing work for years in the axle lathes of the Midvale Steel Company. The gain in cutting speed of these standard broad-nosed tools over our standard round-nosed tools, shown in Figs. 14 and 15, is in the ratio of 1.30 : 1. This general shape of tool continues to be extensively used, but it is subject to the disadvantage that it is likely to cause the work to chatter, and so leave a more or less irregular finish. Were it not for this difficulty, added to the fact that our standard round-nosed tool has a greater all-round adaptability and convenience, the tools illustrated in Figs. 22, 23, and 25, would undoubtedly be the proper shapes for shop standards.



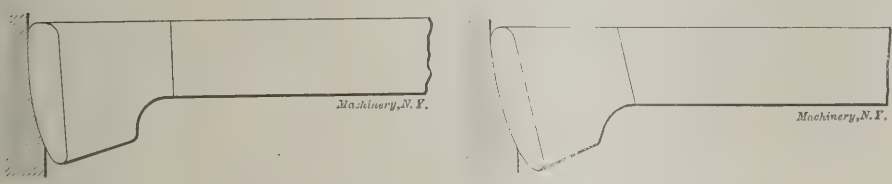
Figs. 19, 20 and 21. Standard Sizes of Tools.

Small Radius of Curvature Tends to Lessen Chatter.

Since the thickness of the shaving is uniform with straight edge tools, it is evident that the period of high pressure will arrive at all points along the cutting edge of this tool at the same instant and will be followed an instant later by a corresponding period of low pressure; and that when these periods of maximum and minimum pressure approximately correspond to, or synchronize with, the natural periods of vibration either in the forging, the tool, the tool support, or in any part of the driving mechanism of the machine, there will be a resultant chatter in the work. On the other hand, in the case of tools with curved cutting edges, the thickness of the shaving varies at all points along the cutting edge. From this fact, coupled with Dr. Nicolson's experiments, it is obvious that when the highest pressure corrresponding to one thickness of shaving along a curved cutting edge is reached, the lowest pressure which corresponds to another thickness of shaving at another part of the cutting edge is likely to occur at about the same time, and that therefore variations up and down in pressure at different parts of the curve will balance or compensate one for the other. It is evident, moreover, that at no one period of time can the wave of high pressure or low pressure extend along the whole length of the curved cutting edge.

tool could be completely resharpened. On the other hand, it is clear that if the tool were to be ground on its clearance flank alone, a much larger amount of metal must be ground off before entirely restoring the line of the cutting edge. This shows that for economy tools must be ground both upon their lip and clearance surfaces.

In many shops the practice still prevails of merely cutting a piece of the proper length from a bar of steel and grinding the curve or outline of the cutting edge at the same level as the top of the tool, as shown in Figs. 24 and 26. This entails the minimum cost for dressing, but makes the grinding very expensive, since the lip surface must be ground down into the solid bar of steel, thus bringing the corner of the grindstone or emery wheel at once into action and keeping it continually at work. This quickly rounds over the corner of the stone, and necessitates its frequent truing up, thus increasing the cost of grinding, both owing to the waste of the stone and the time required to keep it in order; and it also leaves the face of the grindstone high in the center most of the time, and unfit for accurate work. As far as possible, then, the shape of standard cutting tools should be such as to call for little or no grinding in which the corner of the emery wheel does much work. With the type of tool illustrated in Fig. 26, also, comparatively few grindings will make



Figs. 22 and 23. Examples of Broad-nosed Tools.

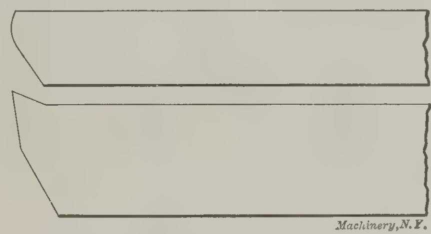


Fig. 24. Common, but Objectionable, Way of Dressing Tools.

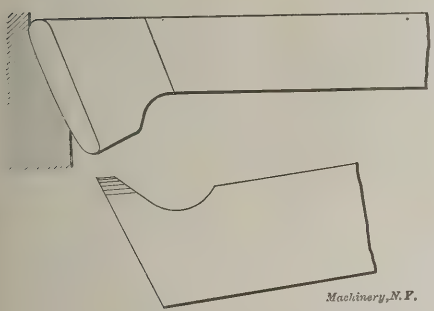
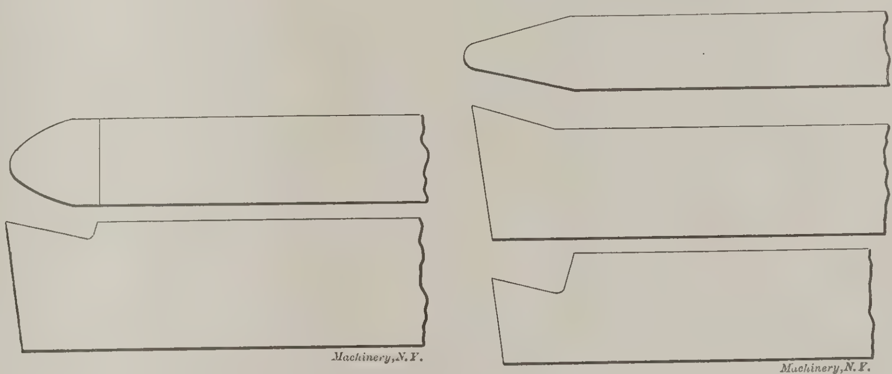


Fig. 25. Example of Broad-nosed Tool.



Figs. 26 and 27. Incorrectly Dressed Tools.

Combined Cost of Forging and Grinding Considered.

In adopting the general shape or conformation of a tool (we do not here refer to the curve of the cutting edge), the most important consideration is that of selecting a shape with which the largest amount of work can be done for the smallest *combined cost of forging or dressing and grinding*, and the dressing is much the more expensive of these two operations. It is, therefore, of paramount importance to so design the tool that it can be ground:

a. The greatest number of times with a single dressing;

b. With the smallest cost each time it is ground.

Modern high-speed tools when run at economical speeds are injured much more upon the lip surface than upon the clearance flank. Therefore, at each grinding a larger amount of metal must be ground away from the lip surface than from the clearance flank; and yet in many cases the clearance flank will be more or less injured (rubbed or scraped away) below the cutting edge, and it therefore becomes necessary, for maximum economy, in practical use, to grind roughing tools both upon their lip and their clearance surfaces.

In Fig. 8 (February issue) is shown the typical wear on a tool which has been run at an economical speed. This tool has been guttered out on the lip surface and also slightly rubbed away on its clearance flank. It is evident that if it were ground on the lip surface alone a considerable amount of the metal would be wasted before the cutting edge of the

a deep depression in the body of the tool, as shown in the lower view of Fig. 27, and this depression will, of course, be greater the steeper the back slope of the lip surface of the tool.

To avoid these difficulties, perhaps the larger number of well-managed machine shops in this country have adopted a type for dressing their tools in which the front of the tool is forged slightly above the level of the tool, as shown in the lower view of Fig. 24 and in the middle view of Fig. 27. This type of tool dressing is done in each of the following ways:

A. By laying the tool on its side and slightly flattening its nose by striking it with a sledge, thus narrowing the nose of the tool and at the same time raising it slightly above the level of the top of the tool.

B. By cutting off the clearance flank of the tool at a larger angle than is demanded for clearance, and then slightly turning up the cutting edge of the tool through sledging upon the clearance flank while the tool is held upon the edge of the anvil with its shank below the level of the anvil.

The objection to both of these types is that the tools require redressing after being ground a comparatively small number of times, and that when redressed in many cases the whole nose of the tool is cut off and thrown away. This waste of metal, however, is of much less consequence than the frequency of dressing. With the first of these types of tool dressing the tendency is to make the nose of the tool too thin, that is, having too small a radius of curvature, and thus to furnish a tool which must be run at too slow a cutting speed.

HOBS AND DIE TAPS.

ERIK OBERG.

Hob taps are, as a rule, only intended for final finishing or sizing of the thread in dies. For this reason their construction differs widely from that of ordinary hand taps. They are not supposed to have any actual cutting to do, being merely used for burring a thread already cut with ordinary taps. Straight hob taps are not relieved at all whether on the top or in the angle of the parallel portion of the thread. Two or at most three threads, however, are chamfered at the point of the tap, and these chamfered threads are relieved on the top of the thread the same as ordinary hand taps. A taper hob, of course, should be slightly relieved on the top as well as in the angle of the thread. The flutes of a hob tap constitute the essential difference of this tap from the hand tap. The number of the flutes is greater and the cutters used are usually regular angular cutters of 50 degrees inclusive angle, 25 degrees on each side. They should have a very slight round joining the angular sides. The dimensions of ordinary hob taps are made the same as for regular hand taps. These were given in the supplement to the January issue of MACHINERY and the only additional information, therefore, is the number of the flutes. These will be found from the table of Sellers hobs in the supplement, the number of flutes being made the same for these latter hobs as for regular ones.

The Sellers' hobs are a special kind of hob taps differing from the ordinary hob tap therein that they are provided with a guide at a point of the thread. The diameter of this guide or pilot is given in the table in the supplement according to the ordinary method in practice. The other dimensions are given approximately according to formulas below in which:

$D =$ diameter of hob,
$A =$ total length of the hob,
$B =$ length of the pilot,
$C =$ length of the thread,
$E =$ length of the shank,
$G =$ the size of the square, and
$H =$ the length of the square.

Formulas for hobs up to 2 inches in diameter are:

$$A = 5\tfrac{3}{8}D + 3\tfrac{3}{8},$$
$$B = \frac{5D}{2} + \tfrac{5}{8},$$
$$C = \frac{5D}{2} + \tfrac{5}{8},$$
$$E = \frac{3D + 17}{8},$$
$$G = \tfrac{3}{4} \times \text{diameter of shank},$$
$$H = \frac{3D + 5}{8}.$$

For sizes of Sellers' hobs, 2 inches in diameter and more, use the formulas:

$$A = 3\tfrac{3}{8}D + 7\tfrac{3}{8},$$
$$B = \frac{3D}{2} + 2\tfrac{5}{8},$$
$$C = \frac{3D}{2} + 2\tfrac{5}{8},$$
$$E = \frac{3D + 17}{8},$$
$$G = \tfrac{3}{4} \times \text{diameter of shank},$$
$$H = \frac{3D + 5}{8}.$$

The diameter of the shank should be made about 1-64th smaller than the diameter of the root of the thread. The guide or pilot should always be hardened and ground.

Die taps are used for cutting the thread in the die in one single operation from the blank and are supposed to be followed by the hob tap. The die tap is provided with a long chamfer portion and a short straight or parallel thread. If to be followed by a hob tap, the parallel portion should be slightly under the standard size so as to leave enough metal for the hob tap to remove to insure the correct size of the die. This difference in size should be not only on the top of the thread but in the angle of the thread as well, so that any inaccuracy in the lead of the thread may be taken care of. On the other hand it must be remembered that the difference must be very slight, as the hob cannot remove very much stock, having a very short chamfer and very small chip room for the stock removed. If this is not taken into consideration the dies may be injured in the sizing operation. It may not be out of the way to point out that one should never try to cut the full thread in the die with a hob as this is purely impossible if any satisfactory results whatever are expected. It probably seems unnecessary to mention, but the writer knows of cases where persons, supposedly well-informed as to the use of tools, have bought hob taps for the purpose of cutting dies with these taps in one operation, and after having met with failure in accomplishing this, have complained that the tools supplied were not satisfactory.

Returning to die taps we may say that they are very similar to machine taps and are made almost exactly in the same way. The flutes are cut with the same fluting cutters as used for machine taps. The die taps are relieved both on the top of the thread and in the angle of the thread on the chamfered portion, and they are threaded on a taper for a short distance from the point of the tap the same as machine taps. On the end of the die tap a straight pilot may be provided with advantage. This will help in guiding the tap straight when starting the thread. Some manufacturers do not provide their taps with a straight pilot on the end, simply chamfering it all the way down to the point, but make the diameter of point below the root diameter of the thread for a distance equivalent to the length of the guide. This, of course, serves no other purpose than to aid in facilitating the point of the tap to easily enter the hole in the die blank and does in no way guide or start the tap straight. When these taps are to be used for threading dies which have already been provided with clearance holes, they should be fluted with somewhat narrower flutes than otherwise, leaving the lands fairly wide, and preferably be given a greater number of flutes than normally. This will permit the tap to pass through the die without deviating from its true course. In the supplement will be found a table giving complete dimensions for these taps. The dimensions are figured from the formulas below. In these formulas:

$D =$ diameter of the thread,
$A =$ total length of die tap,
$B =$ length of the thread,
$C =$ length of the shank,
$E =$ length of the straight thread,
$F =$ length of the pilot,
$G =$ size of the square, and
$H =$ length of the square.

For diameters below 2½ inches the following formulas are used:

$$A = 5\tfrac{3}{4}D + 3\tfrac{3}{4},$$
$$B = 4\tfrac{1}{4}D + 1\tfrac{3}{4},$$
$$C = 1\tfrac{1}{2}D + 2,$$
$$E = D,$$
$$F = \sqrt{D} - \tfrac{1}{8},$$
$$G = \tfrac{3}{4} \times \text{the diameter of shank},$$
$$H = \tfrac{5}{8}D + 7/16.$$

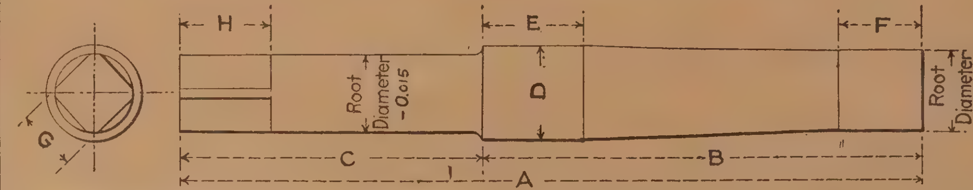
For sizes 2½ inches and larger the following formulas are used:

$$A = 3\tfrac{1}{2}D + 9\tfrac{3}{8},$$
$$B = 2D + 7\tfrac{3}{8},$$
$$C = 1\tfrac{1}{2}D + 2,$$
$$E = D,$$
$$F = \sqrt{D} - \tfrac{1}{8},$$
$$G = \tfrac{3}{4} \times \text{diameter of the shank},$$
$$H = \tfrac{1}{8}D + 1\tfrac{1}{16}.$$

It must be plainly understood that the formulas given are for guidance only, and that no hard and fast rule could be made in regard to the dimensions. Formulas are given for so insignificant a dimension as the length of the squared portion of the shank only in order to facilitate a systematic arrangement of the values in the tables in the supplement.

PROPORTIONS OF TAPS.—V.

DIMENSIONS OF TAPER DIE TAPS-I



Diameter of Tap	Total Length	Length of Thread	Length of Shank	Length of straight Thread	Length of Pilot	Size of Square	Length of Square	Number of Flutes
D	A	B	C	E	F	G	H	
1/4	5 3/16	2 13/16	2 3/8	1/4	3/8	1/8	9/16	5
5/16	5 1/2	3 1/16	2 7/16	5/16	7/16	5/32	5/8	5
3/8	5 7/8	3 5/16	2 9/16	3/8	1/2	3/16	11/16	5
7/16	6 1/4	3 5/8	2 5/8	7/16	9/16	1/4	11/16	5
1/2	6 5/8	3 7/8	2 3/4	1/2	5/8	9/32	3/4	5
9/16	6 15/16	4 1/8	2 13/16	9/16	5/8	5/16	13/16	5
5/8	7 5/16	4 3/8	2 15/16	5/8	11/16	11/32	13/16	5
11/16	7 11/16	4 11/16	3	11/16	11/16	13/32	7/8	6
3/4	8 1/16	4 15/16	3 1/8	3/4	3/4	7/16	7/8	6
13/16	8 3/8	5 3/16	3 3/16	13/16	3/4	1/2	15/16	6
7/8	8 3/4	5 7/16	3 5/16	7/8	13/16	1/2	1	6
15/16	9 1/8	5 3/4	3 3/8	15/16	13/16	9/16	1	6
1	9 1/2	6	3 1/2	1	7/8	5/8	1 1/16	6
1 1/8	10 3/16	6 1/2	3 11/16	1 1/8	15/16	11/16	1 1/8	6
1 1/4	10 15/16	7 1/16	3 7/8	1 1/4	1	3/4	1 3/16	7

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PROPORTIONS OF TAPS.—VI.

DIMENSIONS OF TAPER DIE TAPS-II

Diameter of Tap	Total Length	Length of Thread	Length of Shank	Length of straight Thread	Length of Pilot	Size of Square	Length of Square	Number of Flutes
D	A	B	C	E	F	G	H	
1 3/8	11 5/8	7 9/16	4 1/16	1 3/8	1 1/16	13/16	1 5/16	7
1 1/2	12 3/8	8 1/8	4 1/4	1 1/2	1 1/8	15/16	1 3/8	7
1 5/8	13 1/16	8 5/8	4 7/16	1 5/8	1 1/8	1	1 7/16	7
1 3/4	13 13/16	9 3/16	4 5/8	1 3/4	1 3/16	1 1/16	1 1/2	8
1 7/8	14 1/2	9 11/16	4 13/16	1 7/8	1 1/4	1 1/8	1 5/8	8
2	15 1/4	10 1/4	5	2	1 5/16	1 1/4	1 11/16	8
2 1/8	15 15/16	10 3/4	5 3/16	2 1/8	1 5/16	1 5/16	1 3/4	8
2 1/4	16 11/16	11 5/16	5 3/8	2 1/4	1 3/8	1 7/16	1 13/16	9
2 3/8	17 3/8	11 13/16	5 9/16	2 3/8	1 7/16	1 1/2	1 15/16	9
2 1/2	18 1/8	12 3/8	5 3/4	2 1/2	1 1/2	1 9/16	2	9
2 5/8	18 9/16	12 5/8	5 15/16	2 5/8	1 1/2	1 11/16	2	9
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2 7/8	19 7/16	13 1/8	6 5/16	2 7/8	1 5/8	1 13/16	2 1/16	10
3	19 7/8	13 3/8	6 1/2	3	1 5/8	1 7/8	2 1/16	10
3 1/4	20 3/4	13 7/8	6 7/8	3 1/4	1 11/16	2 1/16	2 1/16	10
3 1/2	21 5/8	14 3/8	7 1/4	3 1/2	1 3/4	2 1/4	2 1/8	10
3 3/4	22 1/2	14 7/8	7 5/8	3 3/4	1 13/16	2 7/16	2 1/8	10
4	23 3/8	15 3/8	8	4	1 7/8	2 5/8	2 3/16	10

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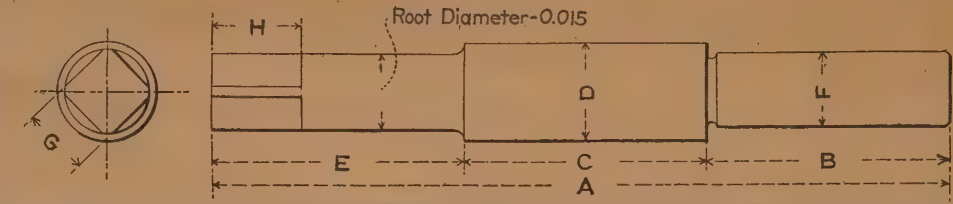
PROPORTIONS OF TAPS.—VII.

DIMENSIONS OF SELLERS' HOBS-I



Diameter of Hob	Total Length	Length of Pilot	Length of Thread	Length of Shank	Diameter of Pilot	Size of Square	Length of Square	Number of Flutes
D	A	B	C	E	F	G	H	
1/4	4 3/4	1 1/4	1 1/4	2 1/4	3/16	1/8	3/4	6
5/16	5	1 3/8	1 3/8	2 1/4	1/4	5/32	3/4	6
3/8	5 3/8	1 9/16	1 9/16	2 1/4	5/16	3/16	3/4	6
7/16	5 11/16	1 11/16	1 11/16	2 5/16	5/16	1/4	13/16	6
1/2	6 1/16	1 7/8	1 7/8	2 5/16	3/8	9/32	13/16	8
9/16	6 5/16	2	2	2 5/16	3/8	5/16	13/16	8
5/8	6 3/4	2 3/16	2 3/16	2 3/8	1/2	11/32	7/8	8
11/16	7	2 5/16	2 5/16	2 3/8	1/2	13/32	7/8	8
3/4	7 3/8	2 1/2	2 1/2	2 3/8	1/2	7/16	7/8	8
13/16	7 11/16	2 5/8	2 5/8	2 7/16	1/2	1/2	15/16	8
7/8	8 1/16	2 13/16	2 13/16	2 7/16	11/16	1/2	15/16	8
15/16	8 3/8	2 15/16	2 15/16	2 1/2	11/16	9/16	1	10
1	8 3/4	3 1/8	3 1/8	2 1/2	11/16	5/8	1	10
1 1/8	9 7/16	3 7/16	3 7/16	2 9/16	7/8	11/16	1 1/16	10
1 1/4	10 1/16	3 3/4	3 3/4	2 9/16	7/8	3/4	1 1/16	10

Machinery, N.Y.

PROPORTIONS OF TAPS.—VIII.

DIMENSIONS OF SELLERS' HOBS-II

Diameter of Hob	Total Length	Length of Pilot	Length of Thread	Length of Shank	Diameter of Pilot	Size of Square	Length of Square	Number of Flutes
D	A	B	C	E	F	G	H	
1 3/8	10 3/4	4 1/16	4 1/16	2 5/8	1 1/16	13/16	1 1/8	10
1 1/2	11 7/16	4 3/8	4 3/8	2 11/16	1 1/16	15/16	1 3/16	10
1 5/8	12 1/8	4 11/16	4 11/16	2 3/4	1 5/16	1	1 1/4	12
1 3/4	12 3/4	5	5	2 3/4	1 5/16	1 1/16	1 1/4	12
1 7/8	13 7/16	5 5/16	5 5/16	2 13/16	1 1/2	1 1/8	1 5/16	12
2	14 1/8	5 5/8	5 5/8	2 7/8	1 1/2	1 1/4	1 3/8	12
2 1/8	14 9/16	5 13/16	5 13/16	2 15/16	1 1/2	1 5/16	1 7/16	12
2 1/4	14 15/16	6	6	2 15/16	1 1/2	1 7/16	1 7/16	12
2 3/8	15 3/8	6 3/16	6 3/16	3	1 1/2	1 1/2	1 1/2	12
2 1/2	15 13/16	6 3/8	6 3/8	3 1/16	1 1/2	1 9/16	1 9/16	12
2 5/8	16 1/4	6 9/16	6 9/16	3 1/8	1 1/2	1 11/16	1 5/8	14
2 3/4	16 5/8	6 3/4	6 3/4	3 1/8	1 1/2	1 3/4	1 5/8	14
2 7/8	17 1/16	6 15/16	6 15/16	3 3/16	1 1/2	1 13/16	1 11/16	14
3	17 1/2	7 1/8	7 1/8	3 1/4	1 1/2	1 7/8	1 3/4	14
3 1/4	18 5/16	7 1/2	7 1/2	3 5/16	2 3/4	2 1/16	1 13/16	16
3 1/2	19 3/16	7 7/8	7 7/8	3 7/16	2 3/4	2 1/4	1 15/16	16
3 3/4	20	8 1/4	8 1/4	3 1/2	2 3/4	2 7/16	2	16
4	20 7/8	8 5/8	8 5/8	3 5/8	2 3/4	2 5/8	2 1/8	16

Machinery, N.Y.

GRINDING CRANKSHAFTS—FOUNDATIONS FOR MACHINE TOOLS.

A recent visit to the shops of the Norton Grinding Co., Worcester, Mass., discovered that concern in the same condition as are practically all the American machine tool builders at the present time—busy. The foundations for an extensive addition to the present shop, nearly doubling its capacity, have been laid, and the building will be erected in the spring. Not content with building grinding machines alone, they have equipped a special department for grinding automobile crankshafts, which, we infer, is not only profitable in itself but is an excellent educator in demonstrating the possibilities of the grinding machine in a field comparatively new. The accompanying Fig. 1 shows this department and will give an idea of the extent of the work now being carried on. About 1,000 crankshafts, mostly of 4-throw, but some of 6-throw type, as will be noted in the foreground, were in this department at the time the photograph was taken, and the weekly production of finished pieces was 125. A considerable number of the leading automobile builders have found that the making of an accurate crankshaft is such a difficult and costly proposition that they have very gladly given over to the Norton Grinding Co. contracts for finishing crankshafts from drop forgings, under guarantee to come within certain close limits for length of throw, parallelism of crankpins, alignment of shaft bearings, general finish, etc. The grinding machine is a tool capable of the most accurate work as all of us very well know who are at all familiar with general machine shop practice, but that it is also a machine capable of removing large amounts of stock in a very short time under conditions that make the operation of ordinary cutting tools very difficult, is not so well-known as it should be.

The crankshafts come to the shop in the rough drop forged form. They are first centered and then are rough ground. It is not seldom that it happens that the amount of the metal that must be removed is such as to mean a reduction in diameter of 3/16 or even ¼ inch. The work is not traversed when grinding pins and bearings; the wheel attacks the material, the full width of the crankpin, rough grinding it in from four to five minutes. After being rough ground the crankshafts are taken to a lathe and the fillets are rough turned with a lathe tool, as it has not been found economical or good practice to attempt to grind the fillets on the grinding machine. After the fillets are rough turned the cranks are returned to the grinding machine for finish grinding, after which the fillets are finish turned again on the lathe. The inspection is very rigid and in the case when long shafts are tested it has been found to be necessary to test in a vertical position on account of the slight deflection of the shaft due to its own weight when suspended at the two outermost bearings. An interesting fact developed in this work where so many different designs of crankshafts are being machined, is that those on which it is unnecessary to break the scale on the crank webs, give by far the least trouble in getting accurate alignment, and where the webs are inclined at an obtuse angle to the crankpin the conditions are still more favorable.

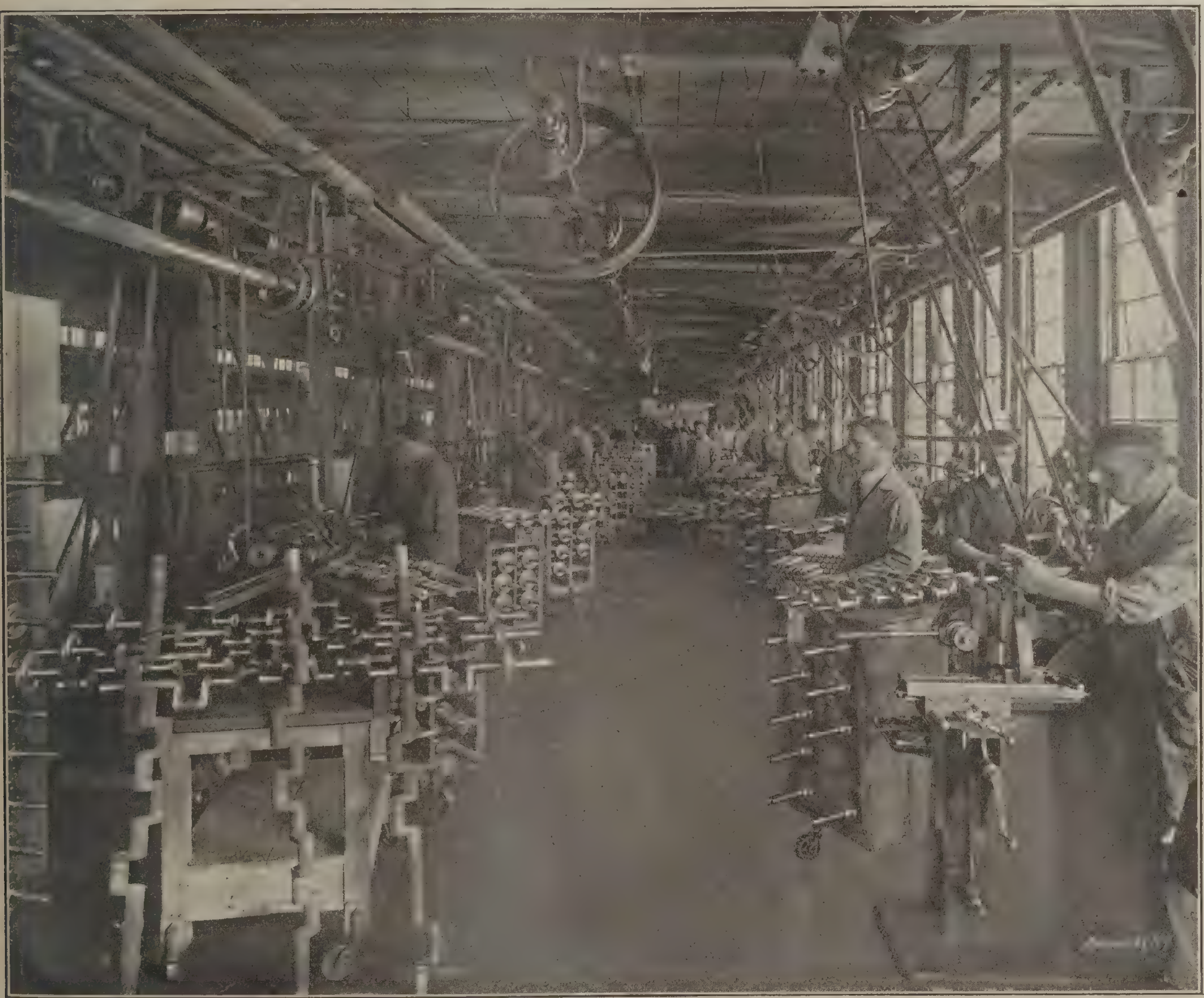


Fig. 1. Automobile Crankshaft Grinding Department, Norton Grinding Co.

That this department is not only profitable as a producer of finished crankshafts, but is an effective object lesson in showing manufacturers what the actual possibilities of the grinding machine really are, is obvious to anyone who has visited the shop, seen the work and learned what the cost of producing finished crankshafts is. We will not give here the figures, but the cost is a sum so small as to appear ridiculous to one who has only followed the older methods. While some of the other finished work that is kept in the shop for

show purposes is of much interest, as for example, ground locomotive piston rods, rolls for flour mills and rolling mills, huge sections of steel pipe, ground and unground to show the rough turning preparatory to grinding, and other large work guaranteed to be parallel, within a limit of 0.001 inch in a length of 8 or 10 feet, the crankshaft grinding department is in itself a live embodiment of possibilities that the others cannot so effectively show.

At the time of the writer's visit Mr. Norton was putting down foundations, of much practical value, for a large planer and milling machine, two views of which are shown in Figs. 3 and 4. The interesting features of this foundation are the method in which it was built up and the adjusting plate used under the planer feet for getting an absolutely level bearing at all points. While adjusting sole plates for planers are by no means new they have generally been made quite inadequate for the purpose required. This plate shown in Fig. 2 is composed of three parts. The base is a heavy casting, truss ribbed on the bottom, and tapped at the four corners for the leveling screws; it is made with two parallel ledges at opposite sides in which are tapped holes for the two adjusting screws. In the center of the base is a boss with an inclined top on which is laid a wedge, this being located directly between the two adjusting screws. On top of the wedge is the actual sole plate so far as the machine tool is concerned. Both upper and lower surfaces of the top plate, and the upper side of the wedge are planed. A spline and groove are also planed in the sole plate and wedge for guidance.

Fig. 3 shows a planer foundation partly constructed, on which eight of these adjusting plates are set preparatory to filling in the foundation with concrete, flush with the top of

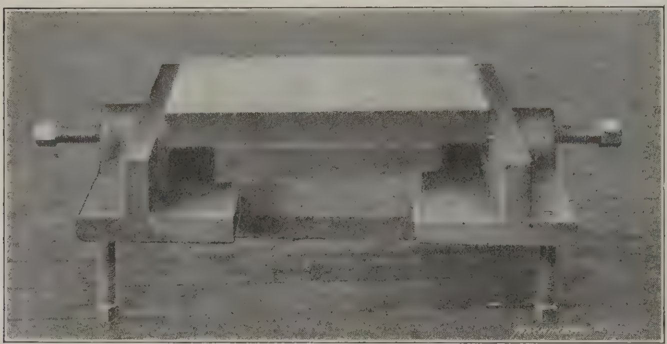


Fig. 2. Adjusting Plate for Machine Tool Foundations.

the sole plate. The foundation is of solid concrete 5 feet deep, and is one monolithic piece the entire length. It is first built up to within 8 or 10 inches of the floor and then the adjusting plates are set and each leveled by the four leveling screws. By adjusting these screws the top plates are all made level and all are brought exactly into the same plane; this condition is carefully tested with a 15-foot Brown & Sharpe straightedge. Tissue paper is used under the straightedge to test the plates at all points, crosswise, lengthwise and diagonally.

After being leveled in this manner the foundation is filled in to the floor level as shown in Fig. 4. This view shows a completed foundation made in the above manner for a Beaman & Smith milling machine, and includes twelve of the adjusting plates. The adjusting screws are barely visible in the halftone but the pockets left for a wrench are plainly shown. After the machine is in place and leveled, the pockets are covered with small castings which keep out chips and dirt. These adjusting plates are intended not only for obtaining correct original alignment of the machine, but are also to be used whenever it is found that there is the slightest inaccuracy in the work produced. It is entirely possible with these adjusting plates to spring a milling machine or planer bed so as to make it plane or mill true at any time, whether the machine be new or considerably worn. With planers set on such a foundation it is easy to turn out work that is dead straight and on which there will be needed the minimum of scraping and other corrective work.

In this connection it is of interest to note that Mr. Norton has found it unnecessary to bolt a planer to the foundation at all. It is the practice to drill one or more pairs of the adjusting plates and put in a half-inch pin at either side on one or more pairs of the planer feet to prevent the planer from sliding endwise, but it has been found in those cases where the pins did not touch the planer, when first put down, that the planer has never moved enough to cause them to touch. Inasmuch as it has been customary to bolt planers down this is valuable experience. Mr. Norton believes that

Fig. 3. Concrete Block Foundations for Planer, with Adjusting Plates in Position and ready for the Concrete Filling.

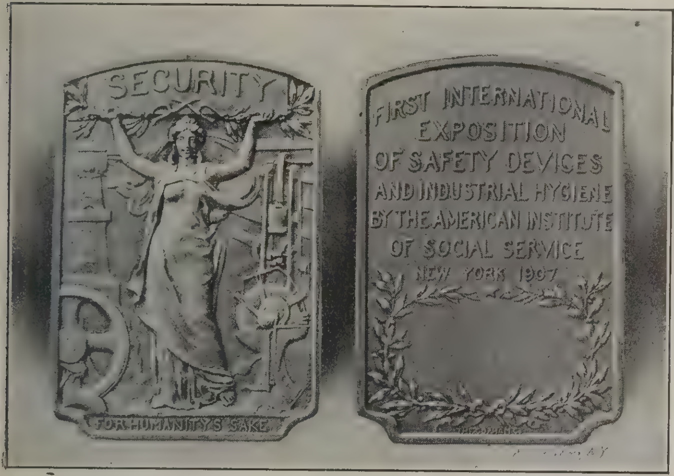
a modern planer that is heavy enough to be of real service cannot be moved by any reversal of the table, and that the foundation should be one that *supports*, but not one necessarily to hold a machine tool down. The company is putting down all their foundations on this plan, and although the original investment is considerable they believe that it is warranted on account of saving a large percentage of the scraping ordinarily necessary. To illustrate, they have a 36 x 36 x 18-foot planer placed on such a foundation which was leveled as described. After the table had been planed after a year's use, tests made with the 15-foot Brown & Sharpe straightedge on the table with tissue paper under either end and under the center showed that the table was accurate at whatever position along the bed of the planer it was placed. Mr. Norton suggests that, if any of our readers have doubts about this being a not unusual condition, let them try it on an average planer as set up in most of our manufacturing plants and find what the results are. In all probability they will be greatly surprised at the inaccuracy found, and the differences at various points on the bed. By making the foundation in one solid piece of concrete and using the leveling arrangement described, it is a matter of everyday occurrence to plane work to a degree of accuracy that was

Fig. 4. Completed Foundation, with Adjusting Plates for Beaman & Smith Milling Machine.

formerly considered entirely impossible. Inasmuch as the accuracy of planed surfaces is so vital to the success of the grinding machine, we may well believe that Mr. Norton's machine foundations represent another step in the advancement of machine tool practice.

VISIT TO THE EXPOSITION OF SAFETY APPLIANCES.

When the writer entered the space allotted to the safety appliance exposition in the Museum of Natural History, the first thing that struck him was a young man who was anxious to explain the merits of the Monarch engine stop. The young man was interesting and the listener was interested, so they went together to the booth where the apparatus was installed and examined the system. While the general principle of the device was familiar enough, a number of little incidental safeguards were brought out in the demonstration, all tending to show how much thought and care had been given to making its operation as sure as anything mortal can be. For instance, the automatic closing device is attached to the same valve the engineer has to use every time he starts and stops the engine, and is thus fairly assured to be in good working order. A circuit breaker is thrown open to disconnect a direct-connected generator when it is operating in multiple with others, thus obviating the danger of having the dynamo act as a motor. The various push buttons which may be located around the shop, and the speed limit device which is directly attached to the main shaft, are all connected by a double circuit mechanism in such a way as to require the breaking of three out of four wires to prevent its action. A testing button is provided which throws all the various circuits into series and rings a buzzer when the button is pressed. This buzzer is wound for a higher resistance than the whole of the rest of the circuit so that if it fails to respond, thus indicating that the batteries are too weak to operate the device, they will still be strong enough for two or three days longer. Before he left, the writer felt really sorry that he did not own an engine to which he might apply one of these stop devices. Having said good-bye to the young man and borrowed his pencil, he continued his tour of inspection, carefully refraining, however, owing to lack of time, from being drawn into further conversation with other demonstrators.



Commemorative Medal Presented to Exhibitors, First International Exposition of Safety Appliances, New York, Jan. 29 to Feb. 12, 1907.

There were a number of manufacturers represented whose names are familiar to the readers of MACHINERY. There was a Flather shaper, electrically driven, with all gearing enclosed so as to be out of harm's way. The Safety Emery Wheel Co. of Springfield, Ohio, showed a wheel which had been ruptured by excessive speed, but which had yet held together instead of throwing itself promiscuously around the shop. Another gear-driven and protected machine was a miller shown by the Garvin Machine Co. The Norton Grinding Co. exhibited a stand with steel guard bands surrounding the wheels. The General Electric and Westinghouse Companies showed a large number of photographs, some of them bearing directly and some very remotely on the questions under consideration.

Of the photographic exhibits made by well-known firms, one of the most instructive was that of the Brown & Sharpe Mfg. Co. Guards covering the change gears of lathes in their shops were illustrated together with band saw guards, exhaust arrangements for grinders, washroom and lavatory fittings, etc. One drawing called attention to an important matter in the arrangement of pulleys on the countershaft. It was shown that the space between the pulley and the hanger should be wider than the belt, so that if it runs off the pulley there will be no danger of its being wedged between the pulley and the hanger; the difficulty of removing a belt in this condition has often led to serious accidents. The overhead cone pulley belt shifter with which their shop is fitted was also illustrated.

In that part of the exhibition devoted to models and commercial exhibits were a number of devices ranging from the serious, through the hilarious, to the pathetic. Safety gas burners were shown which would shut off the supply of gas if the light were accidentally or otherwise blown out, respirators, goggles, and face masks for workers in atmospheres charged with dust and in positions of danger from flying fragments; first aid cabinets for the sick and injured; fusible plugs for boilers; lamps which could be turned bottom side up without disturbance of equanimity on the part of the lamp or the person carrying it, and so on. Most of these are of commercial importance and thoroughly practicable. Some of them were in model form and showed crude ideas and inexperience in practical working conditions on the part of the inventor. Verging on the pathetic was the exhibit of a model of a street car fender; it was applied to a little toy car which had been bought at some children's store. The fender part of it had been made painfully and clumsily, evidently by fingers not used to such work, but anxious to express the idea with which the mind of their owner was charged. Sad to say, there was nothing new or original in the device; it was merely the obvious first thought of an inexperienced inventor.

Perhaps the most suggestive part of the whole was the collection of photographs relating to the exhibits in the various "museums of security" in Europe. The institutions at Amsterdam, Vienna, and Berlin, were especially well represented. A wide range of industries is represented in these pictures; safety stagings, brakes, gas engine starting devices, blankets for rock blasting, belt shifting devices, carboy cases, gage glass guards, barrel skids, etc., in great numbers are represented by pictures from full-sized models. In the Berlin exhibit was shown a picture of a universal grinding machine, with an internal attachment at work and an exhauster connected to the rear end of the work spindle, thus drawing the dust back through the spindle and out of the way of the operator. It was interesting to note that the machine was evidently one of those built by the Brown & Sharpe Mfg. Co.

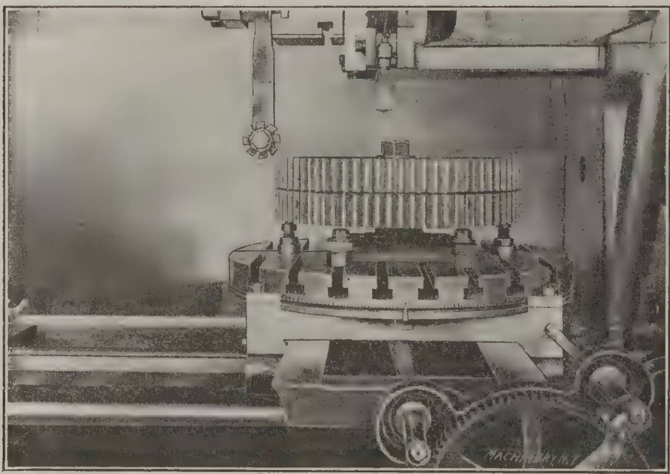
Various devices were shown for making press work less dangerous. One of them, for instance, had the die enclosed by a case with a sliding door in front. This sliding door was attached to the clutch operating lever in such a way that when the clutch was thrown in the door was closed. When the clutch was thrown out and the machine stopped, the door was opened. Another scheme for the same purpose, but permitting somewhat more rapid operation, was one which required the pressure of both hands to start the press going, one hand being applied to a lever on one side of the machine and the other hand at the opposite side. This also made it certain that no damage could be done to the fingers of the operator. Of course, any such device as this in some degree lessens the productive capacity of the machine at the same time it increases the safety of its operation. The owner of much a machine will, in applying these various arrangements, strike a balance between volume of production and safety of operation. The point at which he will draw the line between the practicable and the impracticable will be determined by the fierceness of the competition he has to meet, on one hand, and his humanitarian instincts on the other; the line thus drawn should serve as a reliable index of the progress, both of society and of the individual.

The fact that "museums of security" are recognized and permanent institutions in Europe, and that it has been possible to hold even a temporary exhibit of that kind in this benighted country are encouraging evidences of progress in a direction where progress is much to be desired. It is saying but little to say that this exhibit, made under the auspices of the League for Social Service, has served a useful and commendable purpose.

LETTERS UPON PRACTICAL SUBJECTS.

A METHOD OF CUTTING LARGE CAST IRON GEARS.

The cut herewith shows the manner in which two cast iron gears were cut which were too large for any milling machine in the shop. The gears were three pitch gears having 72 teeth, the width of the gears being 3 inches. It was intended to send these gears to another shop to be cut when it was noted that the table of the Dill slotter in our shop was graduated into 360 degrees, and as 72 teeth were to be cut, the indexing for each tooth would equal 5 degrees. The two gear blanks were then mounted together upon a central pivot which projected slightly into the center of the slotter table. A high-



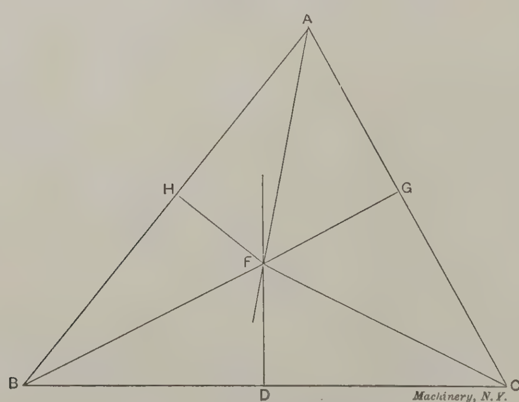
Method of Cutting Large Cast Iron Gears.

speed steel tool was filed to a shape slightly smaller than the width of the space between the teeth, and as nearly to the correct shape of the space as could be done without going to too much expense. This tool was used for roughing out the space between the teeth, using it in any regular slotter bar tool-holder. Then having a regular 3-pitch milling cutter on hand, this was bolted to a steel bar as shown in the cut. A keyway was cut in the hole and a small key inserted to keep the cutter from turning around upon its arbor. A finishing cut was then taken all around the gears, using the cutter as a finishing tool, the indexing being done carefully by moving the slotter table 5 degrees for every tooth. The two gears were cut in this manner in 10½ hours from the time they left the floor until they reached it again. I consider this very good time under the circumstances, only slightly more than four minutes per tooth. The gears came out practically perfect.

M. H. W.

EVERY TRIANGLE IS ISOSCELES.

It may interest some of the readers of MACHINERY to know that the proof given by R. S. in the December issue, as well as the following proof that every triangle is isosceles, may be



Every Triangle is Isosceles.

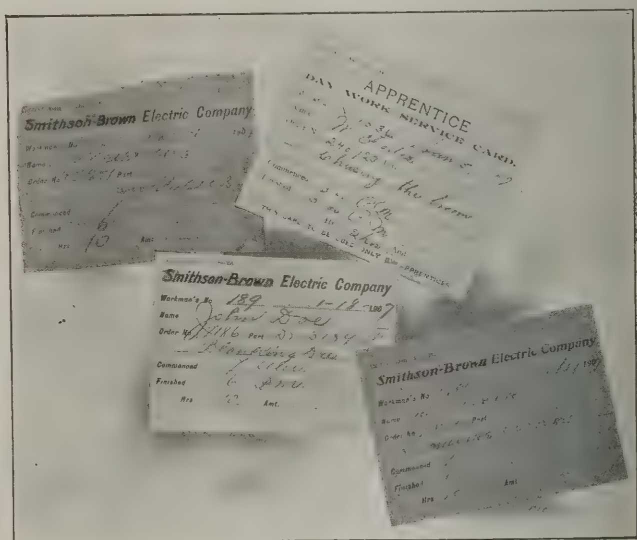
found in a book named "Lewis Carroll Picture Book," published a good many years ago. The proposition that every triangle is isosceles is proven in the following manner: Let ABC be any triangle. Bisect the line BC at D and from D draw a line at right angles to BC. Bisect the angle BAC. Let the bisector of angle BAC intersect the line drawn at right angles to BC at F. Draw FB and FC, and from F draw FG and FH at right angles to AC and AB. Now, the triangles AFG and AFH are equal because they have line AF in common and the angle FGA equal to the angle FHA, and the angle HAF equal to the angle GAF. Thus AH equals AG and FH equals FG. The triangles BDF and CDF are also equal because the line BF is common to both, BD equals DC and the angle FDB equals the angle FDC. Consequently the line FB equals the line FC. The triangle BFH is further equal to the triangle CFG because the line BF has been proven to be equal to FC and FH to be equal to FG, and the angle BHF is, according to the construction, equal to CGF. Thus, the line BH equals CG. We have previously proven that AH equals AG, consequently $AH + HB = AG + GC$ and $AB = AC$. This and every triangle is consequently isosceles. A great many mathematical "proofs" can be made in a similar manner, but the cause for the fallacy is apparent to the thoughtful observer.

T. S. BAILEY.

Quincy, Mass.

HUMAN NATURE IN TIME CARDS.

Most of us are interested, more or less, in the machine shop and the men we find there. Most of us, also, have at some time been in the larger shops, and are familiar with the usual factory systems, no part of which is more in evidence than the time card method of recording the employe's work; to those who have never particularly noticed, it is surprising to observe the amount of a man's character and general make-up which he unconsciously records on his own



Human Nature in Time Cards.

time cards. This fact is very apparent to the clerks and timekeepers, but nowhere is it shown to the average person as clearly as in those shops having a rack, with individual places for the men's cards, where the day's record for each man is placed, shoulder to shoulder as it were, with his shopmates'. In such places the time-card rack is in reality a bulletin of the character, habits and disposition of every man in that shop.

Stand up near the time-card rack about fifteen minutes before closing time some night and notice a few of the men, their time cards and the way they put them up. The first ones up are usually those of the old standbys, who have worked in the shop for years and whose habits are as regular as clockwork, always there when the whistle blows, and ready for work, though they never hurry, and they put up their time cards in a matter-of-fact way at the same time every night. With them life is merely a repetition, day after day, and their time cards show it plainly—always there, full time every day, never an order number missing, and, incidentally, no trouble to the timekeeper.

Notice this fellow coming up the line, stopping to watch what someone is doing now and then. Now he is putting up his time card and looking at the ones all around his at the same time, in an inquisitive sort of way. He is just the same at his work—always more interested in what the others are doing than in what he is doing himself—and that is the reason for most of his many mistakes.

There is an odd-looking card over there—the one on which the wording is all printed out. That man has a fad for lettering and if you happen around some noon you will see him putting in a few minutes practising. The clerk says he likes his time cards because they are so easy to copy off.

The one just under it looks as though a writing teacher or penmanship expert had executed it, so artistic is the writing. You won't find anything awkward looking or acting about the man behind that signature, and he takes real pride in the way he does his work, and especially in the way he finishes it.

Look up here in this corner at this man's time card—neat and clean—clearly written and nothing omitted; it doesn't look as though it had been lying around among his files for a week either. Yes, that is he over there cleaning up his bench and getting ready to go home—he matches his time cards in looks; he has good tools and plenty of them, and knows how to use them; his work is first-class and his name is well up on the rating list; he takes pride in his work and he would be a credit to any shop.

Here is his direct opposite coming up the aisle; look at him slouching along, overalls in rags, shoes falling off, hair uncombed! This is his time card—you can't mistake it—the oil-spotted one with the thumb marks that would put to shame the Chinese method of recording criminals. You can't make anything out of his hieroglyphics but the time clerk has had so many of them that he will translate them, though he may have to go down to see him in the morning; he usually does, and at the same time he will see that absent-minded fellow who forgot to put any order number on his time card. This is the same fellow who forgets to line up his centers after turning tapers, not to mention the borrowed tools he forgets to return.

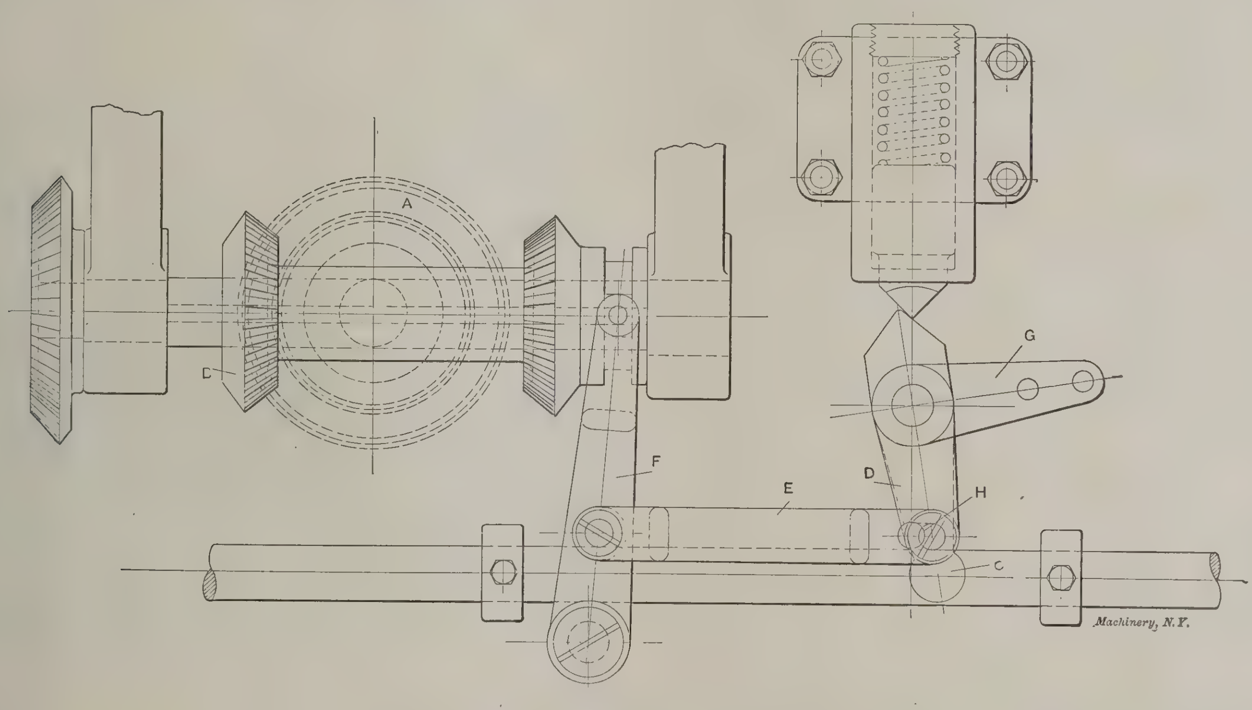
The cards are most all up now but by the blank places you can see there are one or two more to come unless they are absent. This apprentice racing down the line is last nearly every night; he was so busy cutting those threads that he forgot all about his time until the last minute. See him hustle his tools into his drawer so as to be ready to run when the whistle blows. He is the same youngster who helps the sweeper on his Saturday clean-ups and always inscribes his time card "Chasing the broom." There goes the whistle now and there goes the boy followed by the rest of the men with the old standbys bringing up in the rear.

With these few examples we have observed only the most striking of the little earmarks which show up the man whose labor the time card represents, but were we able and willing to go deeper into the subject or even beyond to the study of the handwriting itself the deductions we might make would lay bare human nature far clearer than words could depict. Although no amount of argument would convince the man behind of the truth of our observations, we cannot help seeing it and yet, after all, it is better thus, for what a bitter world it would be if "we saw ourselves as others see us!"

Lynn, Mass. CHESTER L. LUCAS.

AUTOMATIC REVERSING MECHANISM FOR GRINDING MACHINE.

The problem which led to the design of the reversing mechanism shown in the accompanying cut was to get a grinding machine for grinding the bores of cast steel car wheels, the bore being about 1½ inch diameter and larger. Owing to the hardness of the steel used in the wheels, no roughing cut could be taken before the grinding operation. This necessitated that sometimes up to ⅜ inch on the diameter had to be ground out, and in order to make the operating cost of the machine as low as possible it was equipped with automatic reverse for the back and forth motion of the emery wheel, and with automatic feed of the cut.



Automatic Reversing Mechanism for Grinding Machine.

One new feature of the machine in question is that the emery wheel is driven by an independent motor which is mounted on the emery wheel rest so that it travels with the emery wheel. The reversing of the traveling motion is obtained by a driving bevel gear, A, and an engaging double pinion, B, which can slide back and forth on the shaft, but is keyed to it in order to drive. When one end of the pinion engages the driving gear the carriage moves forward, and when the other end of the pinion engages the driving gear the carriage moves backward. This back and forth sliding motion of the pinion is caused by a system of levers, a plunger acted upon by a spring, and a shaft which is fastened to the bed of the machine and is equipped with two collars. By changing the distance between these two collars the length of the traveling motion is changed.

The illustration shows the pinion engaged so that the carriage will move backward. As the carriage moves, the lever C comes in contact with the rear collar. The lever moves and pushes the plunger upward, compressing the spring. During the first half of the period the link E does not move, owing to the oblong slot H, and gear B remains

fully engaged to the driving gear. When the levers *C* and *D* have passed the central position, the pressure of the spring comes into action and pushes the plunger downward. This moves the lever *D*, and by link *E* the motion is transferred to the lever *F* which causes the pinion to slide, disengaging one end and engaging the other. The carriage reverses and starts to move forward. In order to obtain the feed of the emery wheel the lever *G* is connected to the reversing mechanism. At the end of the lever two strings are fastened which are led up to the ceiling, and over sheaves lead down one to each of two ratchets at the end of the feed screw. These ratchets are arranged so that when the carriage reverses at the rear end one of the ratchets feeds, and when the carriage reverses at the front end the other ratchet feeds the cut. O. K.

FLAT FILING.

Too many beginners use a file as though it were a rubbing instead of a cutting tool. Others, again, lift the file clear from the work at each stroke end, to bring it back for the next cut. Either of these ways is apt to result in a "book-back" appearance of the work-piece. Lifting the file on the back stroke has a tendency to throw it out of level; if it be dragged over the work ever so lightly on the back stroke without removing any metal, it is more apt to keep in the same plane as on the cutting stroke.

As regards the pressure, at first the tip should get more, by means of the outstretched fore-finger, than the handle; in the middle of the stroke the pressures on the two ends should balance, and at the end of the stroke the handle should get it.

To practice flat filing, one may take a wood rasp and a piece of hard wood about as large as a thin brick, and file down the long narrow side avoiding "book-backing." After this is done, the best thing is to file a round brass rod to an even square cross section.

But after one has got a piece to what he thinks is the flat condition, he will be apt to find that the straightedge differs from him. Then if he will either clamp the work-piece in a freely swinging holder, or lay it on a piece of cork, he will find that he can file it still flatter. If the piece is very small, it may be filed on the forefinger. Either the swing, the cork or the forefinger follows the tendency of the file to rock, and enables the production of a flatter surface than would be otherwise attainable. ROBERT GRIMSHAW.

Hanover, Germany.

[To get the action of a swinging holder the work may, in some cases, be placed between the centers of a lathe.—EDITOR.]

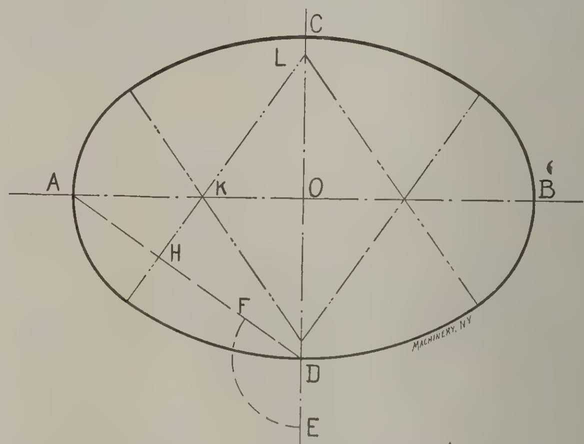
TO DRILL CHILLED CAST IRON.

The hardest chilled cast iron may be drilled by using a common flat drill made of good high carbon steel, as for example, "Crescent double special A-1." This steel can be hardened at a very low red heat which is an imperative requirement for a tool to drill hard material. It should be hardened in a solution of salt water. I have been able with a drill hardened in this manner to drill the hardest chilled iron that can be cast. It might be worth while to remark here that chilled iron can be still further hardened by bluing it on an emery wheel; it will then be so hard that no steel tool can touch it. It should be mentioned that a very powerful and rigid drill press must be used for drilling chilled iron as it takes a tremendous pressure to force the drill into the hardened surface. The attempt to drill chilled iron in a weak drilling machine will be futile as the drill will simply ride up over the surface, not cutting at all and quickly dulling the point. As to speed, I would say use a speed at which the drill will do a reasonable amount of work before dulling. Lubricants are of no advantage whatever. As a measure of speed I would say that it is impracticable to use a peripheral speed of the drill exceeding from 24 to 30 inches per minute. In planing chilled iron a speed of from 18 to 24 inches per minute should be employed and the same applies to turning. Do not attempt to drill chilled iron with an extra or specially machined twist drill; a twist drill has too much top rake to the cutting edges, hence is too weak to stand the pressure. Of course some so-called chilled iron can be drilled with a twist drill, but iron as hard as chilled rolls cannot.

Cincinnati, Ohio. M. B. STANFFERT.

DRAWING AN APPROXIMATE ELLIPSE.

Many of the methods of drawing an approximate ellipse are complicated and difficult to remember and some of them do not give good results unless the ratio of the larger and smaller axes is within certain limits. The cut herewith, which is a direct reproduction of a drawing made according to the method outlined below, shows a simple way of obtaining a very accurate elliptical form. The method is of German origin and is easy to keep in mind. The procedure is as follows: Let *A B* be the larger axis and *C D* the smaller. Draw the line *A D*. From the intersection of the axes, *O*, set off *O E* on the minor axis equal one-half of the larger axis. With *D* as a center and with *D E* as radius, strike the arc *F E*. Bisect *A F* at *H*, and from *H* erect a perpendicular intersecting the axes at *K* and *L*. These two latter points will then



Drawing an Approximate Ellipse.

be the centers for the radii *K A* and *L D* by means of which the approximate ellipse is formed. Of course, the centers for forming the other half of the ellipse are found in a similar manner. S. W. LINN.

Milwaukee, Wis.

[While the methods for drawing an approximate ellipse are many and commonly known, we give publicity to this one, as we consider it exceedingly simple, and think that it will be appreciated by those of our readers who are often called upon to make drawings where ellipses occur.—EDITOR.

GETTING A RAISE.

The best method of getting an increase in salary or wages, better known as a "raise," has been told us over and over again in the Sunday supplements and elsewhere; but there seems to me to be no safer way than that of asking for it and to repeat the request until the desired effect is produced, or the boss gets sore and assures you in plain language that you can't have it and that's all there is to it. A conscientious man will seldom get such a reply, although he may be put off with this or that excuse.

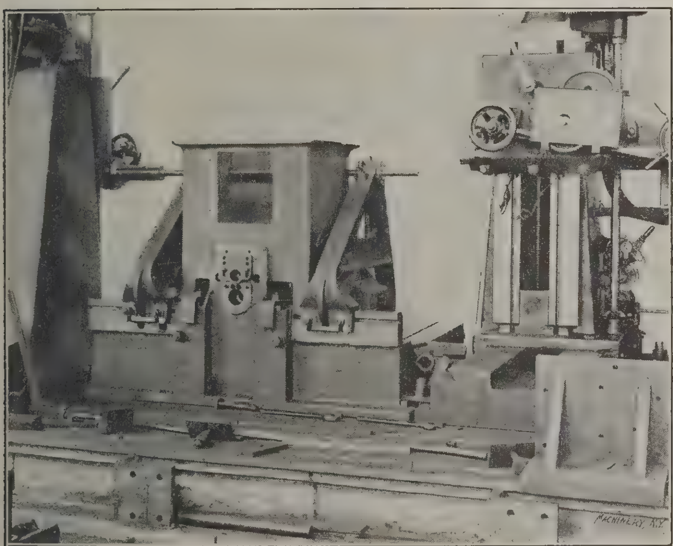
However, the fact that your immediate superior is not always to blame for these delays is illustrated by an experience which I had some two years ago, while working for one of the subsidiary companies of a very large corporation. The head of the department in which I worked was the mechanical engineer of the smaller concern, itself no "one-horse" affair; and I thought all that was necessary was for him to say the word, and my hoped-for bigger check would be a reality. After much maneuvering I got him alone one day and asked him about it; he replied that he thought I had been with the firm long enough to merit an increase, and so far as he was concerned he was perfectly willing to give it to me; but the policy of the company absolutely forbade raising the wages of any employe, though heads of departments could use their own discretion as to the amount to be paid a new man;

and he suggested that if I could get another place for a few weeks or months he could then hire me over at what he thought I was worth. At any rate, I had better get an offer from some other firm, and perhaps then he could fix me up with what might be called a "theoretical" discharge; for a while I was inclined to think he was simply letting me down easy, but I finally secured an offer from another firm in the same corporation, in the shape of a telegram, to come on at once at the figure named; told the boss about it that evening, and the next morning he telephoned to the head office in a distant city to see what could be done. The reply was that in no case could he give me a straight-out increase, but that he might have me taken off the payroll for one day, and start me in at the new rate the next, which he did; and I telegraphed the other people that I had already accepted a position. It was not a very square way to deal with them, but as they were part of the big organization whose red tape had put me to all the trouble, my compunction wasn't very great—not so as to be unendurable in the light of the following paydays. The next time I wanted more money I went elsewhere in earnest. BESSEMER.

Chicago.

A LARGE DRILLING AND BORING JIG.

The jig shown in the accompanying cut is used at the works of the Landis Tool Co., Waynesboro, Pa., for drilling and boring the beds of their smallest size grinding machines. The



Large Drilling and Boring Jig.

cut shows the work in progress on a large horizontal boring mill. The jig consists of a base provided with an adjustable plate for drilling the holes in the front, and adjustable brackets for guiding the bars for boring the ends of the bed. The base consists of a heavy casting, planed at the top, so as to correspond with the planed portion of the top of the bed, so that the latter may be laid bottom up on this base and located transversely by the planed lip on the front of the bed, suitable clamps being provided to hold it firmly in position. At the front of the base of the jig is a vertically projecting flange or apron of sufficient size, and so shaped as to conform to the shape required for locating most of the holes in the front of the bed; at the back part of the base is a smaller flange adapted for carrying a bushing for guiding the bar for one of the larger of these holes. Suitable T-slots are provided in the base for bolting on the various parts, and at the bottom two right-angle grooves are planed to provide for a tongue for locating on the floorplate of the boring mill. The jig is designed to accommodate two sizes of beds or similar cross sections but of different lengths, the difference being such as to only affect the location of the end brackets and some of the holes in the front of the bed. To provide for the difference of these latter holes, the adjustable plate in the front is so designed that it can be located by dowel pins in either of two positions required and is provided with slots for clamping bolts. When boring the holes in the ends of the bed the base of the jig is, of course, turned from the position that it has when the front holes are bored to the position shown in the cut. The end brackets are clamped in place, being located upon the finished surface of the base. T-slots are provided so that these brackets may be shifted in or out to accommodate the different lengths of beds. H. F. NOYES.

Waynesboro, Pa.

THE APPARENT FALLACY OF ALGEBRAIC PRINCIPLES.

In the January number of MACHINERY, R. S. has endeavored to overthrow our fundamental ideas of arithmetic and algebra. Such proceedings are dangerous and I hasten to raise an objection to his methods and results. It would be a dangerous thing if two became equal to one in the matters of every day life. His algebraic processes are perfectly legitimate up to the point where he says, "divide both members by $a - b$. The quotients are then equal." According to his first assumption $a = b$. Therefore $a - b = 0$. It is ordinarily assumed that it is perfectly correct to divide both sides of an equation by the same quantity. This is true unless that quantity is either infinity or zero. If both sides of an equation are divided by infinity or zero, the result is not necessarily correct as it becomes an indeterminate. This may be easily seen by taking a numerical example. For instance, 0 times 7 = 0 times 9. If we should divide both sides of this equation by zero we would have as a result 7 = 9, exactly as R. S. has proven that 2 = 1. I hope that this explanation will convince R. S. that our fundamental laws of arithmetic and algebra still hold good in spite of apparent discrepancies here and there. I might say in conclusion that the two quantities, zero and infinity, must be handled very carefully in algebraic operations. K. G. SMITH.

Wellsville, N. Y.

PORTABLE MACHINES FOR TURNING CRANK-PINS AND CROSSHEAD PINS.

In the accompanying cut, Fig. 1, is shown on a small scale a crankshaft for a 50 x 72-inch reversing blooming mill engine. This shaft was made by the Bethlehem Steel Co. and weighs

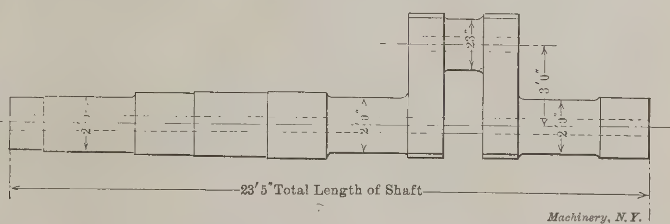


Fig. 1. Crankshaft of Large Blooming Mill Engine.

49,000 pounds. As there is no lathe in the Pittsburg district powerful enough to swing this crankshaft, the crankpins, when worn, had to be filed true by hand, a very unsatisfactory and expensive operation. For this reason the writer designed the

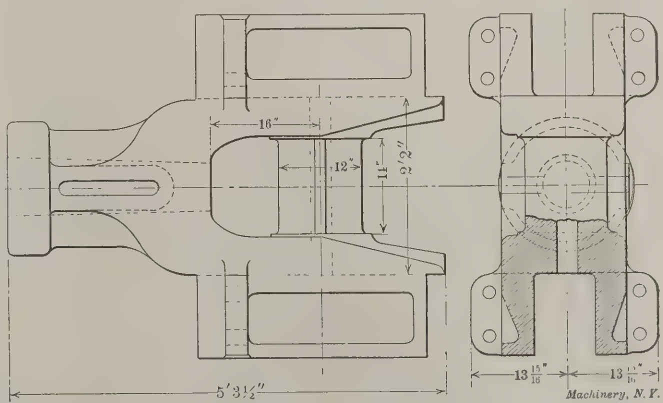


Fig. 2. Crosshead of Large Blooming Mill Engine.

portable crankpin turning machine shown in Fig. 3. This machine consists of frame A made in two parts and clamped to the crankshaft by the brackets B, rods C and pivot D. The frame carries a ring E, also made in two parts, to which the

tool rest *F* is bolted. The lead screw *G* is operated by a star feed. The outer surface of the ring *E* is a wormwheel driven by a worm carried in the frame *A*, all of which is plainly shown in the cut. A sheave pulley is keyed to the wormwheel shaft and is driven by means of any convenient transmission of power. This apparatus has given entire satisfaction, and it may be changed so as to meet almost any case liable to arise.

The writer has also designed a similar tool to turn the crankhead pins for a 50 x 72-inch blooming mill engine. This tool is shown in Fig. 4 and the crosshead with its pin is shown in Fig. 2. There is no other mechanical way, excepting the one shown, known to the writer by which this operation can be carried out. This tool is to a certain extent very much similar to the one first described. It consists of a frame made in two pieces. Inside of this frame is a wormwheel, carrying the tool, driven by a worm and a sheave pulley, the same as in the tool first described. The dimensions of the outer frame are such as to permit it to be placed between the crosshead pin and the crosshead itself. As will be seen from the cuts, the radius of the frame is 15½ inches, while the distance from the center of the crosshead pin to the solid back part of the crosshead is 16 inches. It is obvious that the frame as well as the wormwheel has to be made in two parts, as otherwise there would be no way of placing the piece to be turned in position inside of the arrangement. F. WACKERMANN.

Pittsburg, Pa.

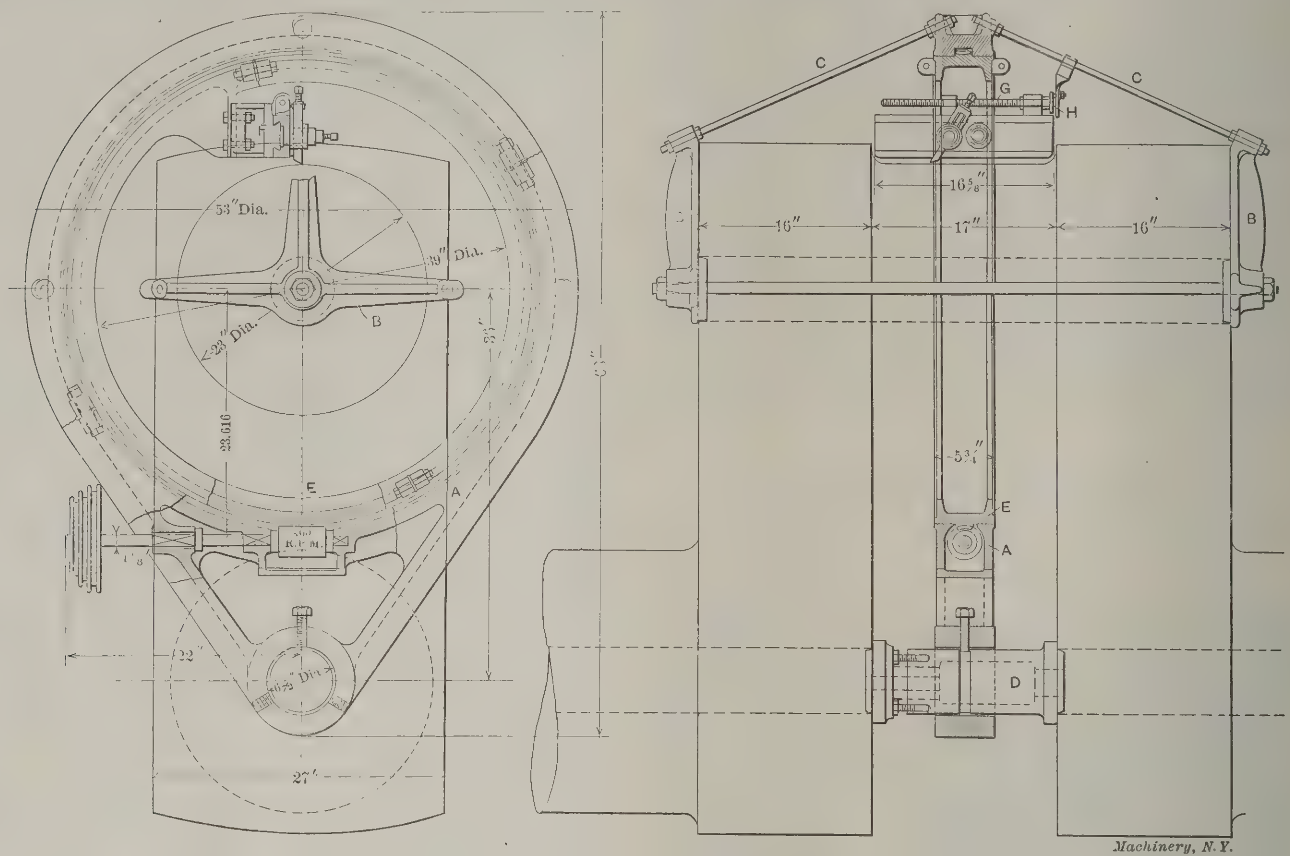


Fig. 3. Portable Crankpin Turning Machine.

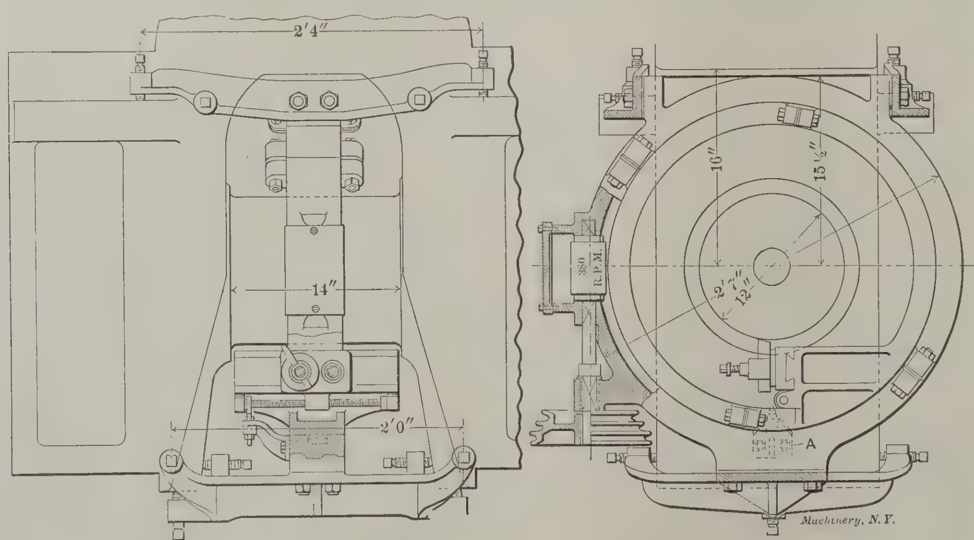


Fig. 4. Portable Crosshead Pin Turning Machine.

THAT ALGEBRAIC PARADOX.

Referring to the algebraic paradox in the January issue, would say that it is not necessary to use algebraic symbols at all; use only the figure 1; thus:

$$1 = 1$$
$$1^2 = 1 \times 1$$
$$1^2 - 1^2 = 1 \times 1 - 1^2$$
$$(1 + 1)\ (1 - 1) = 1(1 - 1)$$
$$(1 + 1) = 1$$
$$2 = 1.$$

Or use any old figure,

$$7 = 7$$
$$7^2 = 7 \times 7$$
$$7^2 - 7^2 = 7 \times 7 - 7^2$$
$$(7 + 7)\ (7 - 7) = 7(7 - 7)$$
$$(7 + 7) = 7$$
$$14 = 7$$
$$2 = 1.$$

Which all reminds me of that no cat has two tails; any cat has more tails than no cat; therefore any cat has more than two tails.

GEO. B. GRANT.

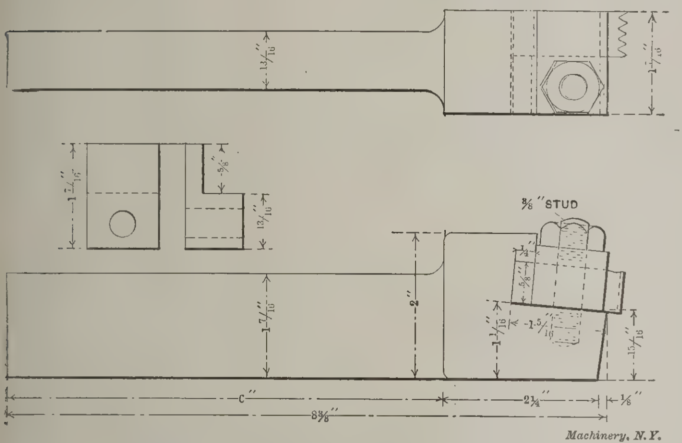
Boston, Mass.

[It is worth while noting, particularly by those who only occasionally make use of algebraic formulas, what failacious conclusions may be drawn from apparently correct use of algebraic expressions. While the laws of mathematics are infallible they demand a constant alertness of the mind not to permit any operations to be performed, which, while apparently correct, are illogical.—EDITOR.]

UTILIZING WORN THREADING DIE CHASERS.

Having a number of Hartness threading die chasers of various pitches, which, after having earned their cost several times over in the Jones & Lamson turret lathes, had become worn on the first two or three threads so as to become useless for the die head, it struck me that these might be used for finishing threads in the lathe by planing them in a suitable holder.

I then made a holder like the cut, and instead of only finishing threads in the lathe it was found that in most cases a thread could be completed in three cuts. After a lathe hand became accustomed to their use there would be no necessity to remove the piece from the lathe to try to fit, but if care had been exercised in first turning the piece to the correct diameter, just as soon as the chaser became filled with the thread the fit was assured. Now, when one gets one of these chasers of any particular pitch, of course one gets four, there



Holder for Utilizing Worn Threading Die Chasers.

being four to a set. I then had the first threads, which were originally tapered or chamfered off, ground away on two chasers in the set to be used when threading up to a shoulder. I left the other two chamfered as they were originally. So successful has this method become that I have found several turners getting the holders made on the "sly," and if not able to secure worn out chasers, to even try to "pinch" good ones from the turret lathe men, which I think is sufficient recommendation to warrant all interested giving it a trial. I am satisfied that threads can be cut so much faster and more accurately by this method that it would even pay to use the new die chasers were no old ones procurable.

Referring to the cut, very little explanation is necessary. The reason for the part of the holder upon which the chaser rests being made angular is to allow sufficient clearance to form a good cutting rake. This was found to be absolutely necessary after actual trial. The top rake, shown ground in the chaser, was found to be better for steel work. I have also made a holder suitable for inside work which I do not think it will be necessary to describe, as any mechanic could devise one. I merely submit the idea to those who may have some of these old chasers lying around the shop, and who have not thought of putting them to use. M. H. W.

HIS NAME WAS DENIS.

It takes all kinds of men to fill up a shop, but it seems as though such a man as Denis might have been left out. Denis was a good fellow all right, but he had a faculty for getting into scrapes. His first job when he struck us, was turning press rolls; they are the distributing rolls used on large job printing presses. Any of you printer fellows will know just what I mean; there is a roughing and finishing chip run over the roll and then the journals are turned up. We were pressed for long lathes to get this work out fast enough, so Denis had to do a lot of overtime work. He ran two lathes, he would rough out on one and then finish on the other.

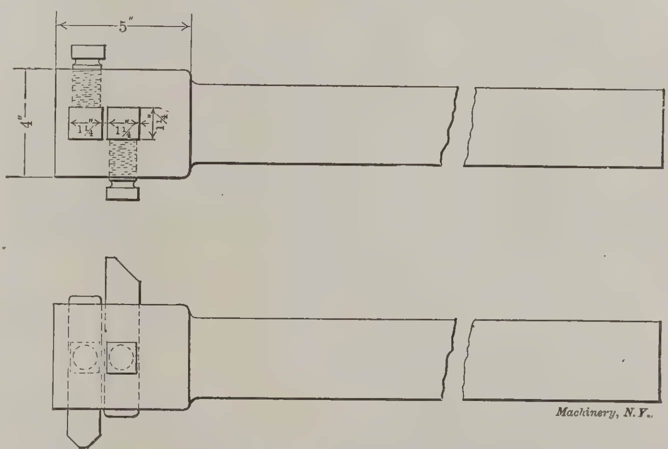
Well, it came to Thursday night and Denis had worked three nights that week, and then he wanted a night off; you boys that ain't married know just how he felt. He didn't dare ask the "Boss" to be off; he knew it was no use; but instead of that he had an inspiration. He started a cut on each lathe as soon as the power started up at 6:30. Then he tied a string on the end of the shipper and the other end of the carriage so that when he had got to the end of the cut, it would pull the clutch out and stop the lathe. The idea was great; but the thing miscarried, in the application. One of the cubs saw what was up, and he gave the cross-feed handle a turn and drew out the tool so that the lathe run on a "wind chip" all the evening. The next morning when the "Boss" came in, he wanted to know why the work wasn't done, and then the whole thing came out. Denis didn't get fired, but he got a "call-down" that will stay with him for a while.

A new man came in about this time and he told us about one of Denis' old feats. It seems he had been put on a big double-head planer; how it came about we couldn't say, and he couldn't tell us, but he got there somehow. The first job was a big locomotive cylinder. Now the planer was served by an overhead crane that dropped the work on the rear end of the table behind the cross-head. Denis set the job up without running it to the front end of the planer. So far, that was all right, but then he started up the planer without looking to see if the cross-head was up far enough to clear the work. Well, it wasn't! It only lacked an inch, but when that casting struck the back end of the heads, it naturally ripped the "stuffing" out of them, for they were not built to take the thrust from that side.

About the time Denis saw the heads going, he had his coat on and was out of the door, and, as the new man continued, "I hadn't seen him since, until I struck here. It cost about five hundred dollars to put the planer back in shape, but that didn't worry Denis any." A. P. PRESS.

BORING TOOL FOR LOCOMOTIVE DRIVING BOX BRASSES.

The accompanying cut shows a boring bar for boring the driving box brasses on locomotives. It may not be new, but having traveled a great deal this summer among railway repair shops I have not seen it in use in any of them. As the brasses are only half a circle, by using only one tool in the toolholder it is evident that work is performed only half of the time, and the machine is not working the other half. But by making the bar as shown and placing a second tool above the first a cut will be taken during the whole revolu-



Boring Tool for Driving Box Brasses.

tion, as one tool commences to cut just as the other leaves off. In many instances, if there is not too much to bore out in a box, it may be finished in one cut, for no matter how heavy a cut is taken by the first tool it leaves off cutting when the second tool commences to take the finishing cut and permits the latter tool to produce a smoothly finished surface. It may be objected that one tool will leave the bore slightly before the other at the end of the cut. To avoid this the second tool may be made with an offset sufficient to bring them both through at the same time. I have also adopted this method for work performed in a horizontal boring mill; by boring the holes which receive the cutters to within ⅜ inch of the opposite side and tapping out the remaining wall with a ½-inch tap and inserting a setscrew, I have secured a good adjustment, which saves setting the tool with hammer blows, which I have frequently seen done during my travels.

M. H. W.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

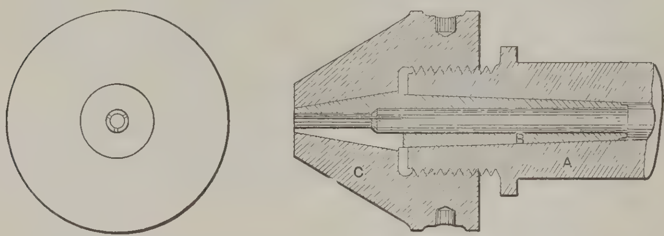
Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

DRILLING PORCELAIN OR GLASS.

To drill porcelain, glass, etc., take a piece of iron wire 1/32 inch smaller than the hole desired and grind one end flat; place it in the drill chuck and speed the drill as high as possible. Feed slowly through the substance, using plenty of emery and oil. NERALCM.

A COLLET CHUCK.

About twenty-four years ago, when the writer was serving an apprenticeship in the toolroom, the "old man" designed a collet chuck of which the sketch herewith is drawn from memory. The principle is not new, but I can vouch for the utility of the tool. We had a good 14-inch lathe with hollow spindle but no collet chucks. Referring to the sketch it will



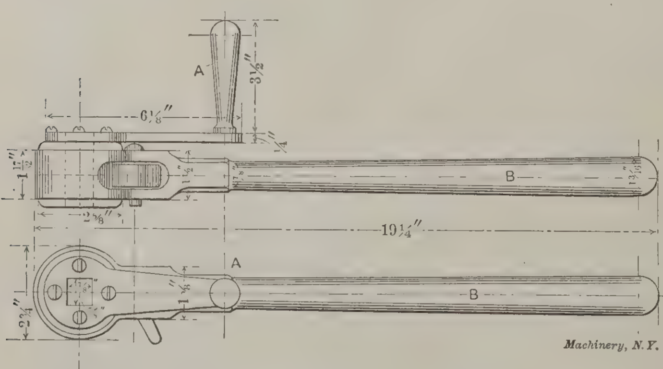
Machinery, N.Y.

be seen that *A* represents the lathe spindle, *B* the tool steel collet and *C* the cast iron compression nut. Several collets were made with holes of various diameters, the largest size being limited by the capacity of the hollow spindle. The collets were split in three parts as shown. The edges of the compression nut were knurled for a hand grip which was sufficient for ordinary work, and spanner holes were also provided. H. D. POMEROY.

Rome, N. Y.

THE REVERSIBLE RATCHET WRENCH AND HANDLE.

The accompanying cut shows a very good improvement on the ratchet wrench used for heavy machinery such as slotters, planers, wheel lathes, and boring mills for operating feed mechanisms, traversing motions, etc. It is in use in the Clinton shops of the Chicago & Northwestern Ry. at Clinton, Iowa. With the small handle *A* attached, the wrench is a combination ratchet and ordinary wrench, and it can be used to good advantage as it is not necessary to remove the wrench from the screw if a quick traverse is desired. For heavy work the long handle *B* is used with the ratchet, and for lighter and



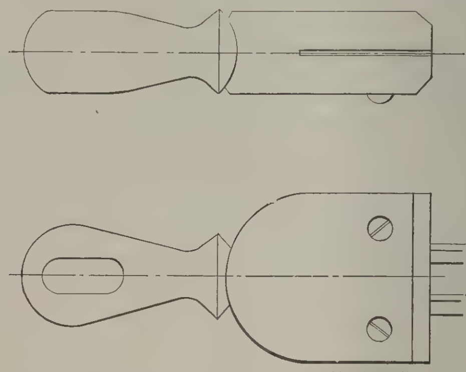
Machinery, N.Y.

quicker work the short handle is operated. This is an important consideration on many machines for the number of changes that must be made in the use of wrenches on screws frequently amounts to a large percentage of a 10-hour day. The small handle can be applied to almost any reversible ratchet wrench used on machine tools, and the cost of application is very small indeed as compared with the increase of efficiency of the tool. It will readily repay the cost of the outlay in a very short time. HARRY F. KILLEAN.

Clinton, Iowa.

SPACING TITLES ON DETAIL WORK.

A drafting-room kink came to my notice some time ago which I have found very useful as a time saver in spacing titles on detail work. It consists of a few needles and a small piece of wood turned as is shown in the cut. Through one end a narrow saw cut is made about an inch deep. Into



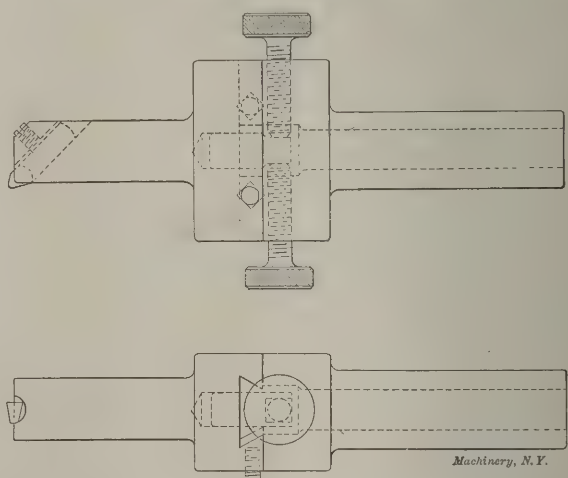
Machinery, N.Y.

this cut are inserted and spaced as many needles as are desired. The needles are bound in place by two round-head wood screws. The cut shows such a spacer set to mark for two lines of letters. RAYMOND C. WILLIAMS.

Worcester, Mass.

BORING TOOL FOR USE IN SCREW MACHINE.

The cut herewith shows a boring tool made for use in the turret lathe, chiefly for operations upon castings. The main feature of the tool is the means provided for setting the tool, which can be quickly and accurately accomplished with the aid of the two knurled head screws, the ends of which impinge upon a stop driven into the cutter holder body. After setting, the knurled head screws are firmly locked up against



Machinery, N.Y.

the stop. The tool steel cutter is held in position in the holder by means of a headless setscrew, which is sufficient to hold it firmly in position. The shank is turned to suit the hole in the turret, the wear in the slide is taken up by means of a gib and setscrews. The stop pin is driven firmly in position through the hole in the shank after the tool is assembled.

J. C. H.

* * *

In making repairs it usually is not a question whether a piece is worth patching up or not, but whether a manufacturing plant can afford to lie idle while new parts are made or requisitioned from the manufacturer. Constructive work and methods are then permissible which would be out of the question in manufacturing work; it would be the height of poor judgment for a repair man to say that it were better to throw away a broken part and make a new one if by any hook or crook he could get it into working shape, and so save the time of men waiting for the wheels to turn again.

* * *

Don't run a polishing wheel on brass work for any great length of time without having a dust trap over your mouth and nostrils; a wet sponge is very good.

SHOP RECEIPTS AND FORMULAS.

A DEPARTMENT FOR USEFUL MIXTURES.

This page will be used for the publication of shop receipts which the contributors know from experience to be practicable. Nearly all readers of MACHINERY can add something, and it is desired that they use this page as a medium for exchanging useful formulas. It makes no difference if they are old and supposedly well-known, provided they have not already appeared in this department.

310. ACID PICKLING FOR FORGINGS.

To remove scale from drop-forgings which have to be machined, dip in a pickle composed of hot water 24 parts, sulphuric acid 1 pint. HARDENER.

311. GOOD CASEHARDENING MIXTURES.

One part sal-ammoniac and 3 parts prussiate of potash; or, 1 part prussiate of potash, 2 parts bone dust and 2 parts sal-ammoniac. E. H. MCCLINTOCK.

West Somerville, Mass.

312. LUBRICATING OIL FOR HEAVY DUTY AND FAST RUNNING JOURNALS.

An excellent lubricating oil for heavy duty and fast running journals may be made by mixing equal parts of sperm oil, cylinder oil and "black strap" or common machine oil.

Moline, Ill. A. D. KNAUEL.

313. EMERGENCY REPAIRS OF BOILER FURNACE.

When it is necessary to repair the boiler furnace and fire brick cannot be obtained, take common earth, mix with water in which has been dissolved a small amount of common salt. Use this mixture the same as fire clay. It will be found to last almost as long. R. E. VERSE.

314. COMPOUND FOR POLISHING BRASS.

To 2 quarts of rainwater add 3 ounces of powdered rotten stone, 2 ounces of pumice stone and 4 ounces oxalic acid. Mix thoroughly together and let it stand a day or two before using. Shake it before using and after application polish the brass with a dry woolen cloth or chamois skin.

Middletown, N. Y. DONALD A. HAMPSON.

315. LUBRICANT FOR DRILLING COPPER.

The best thing in my opinion to use for drilling copper, especially with small drills, is a piece of tallow. I have noticed a great number of receipts given, but I find that this simple means answers the purpose equally well or better than anything else. GEO. W. SMITH.

Marquette, Mich.

316. MIXTURE FOR CLEARING BLUEPRINTS.

It very often occurs, when making blueprints, that a print becomes burned by over-exposure and the lines do not show up well. These may be brought out more clearly by pouring bi-chromate of potash, dissolved in water, over the print while it is in the sink. The print must be washed again with water before it is hung up to dry. HERBERT C. SNOW.

Cleveland, O.

317. TURNING COPPER.

Those who have had to turn copper in the lathe have generally wished that they had let someone else do the work and that they stood by and jeered when it was being performed, or else criticised it after it was done. Soap and water do not help; turpentine is a delusion and a snare; but milk does the trick "with neatness and dispatch." ROBERT GRIMSHAW.

Hanover, Germany.

318. TO REMOVE RUST FROM POLISHED STEEL.

It quite frequently happens that parts of machinery having polished surfaces become rusty. This rust is difficult to remove without scratching the highly polished surface. A very effective mixture for removing rust from such surfaces without injury may be made as follows: Ten parts of tin putty, 8 parts of prepared buckshorn, and 250 parts of spirits of wine. These ingredients are mixed to a soft paste, and rubbed in on the surface until the rust disappears. When no trace of rust seems to remain, the surface is polished with a dry, soft cloth. T. E. O'DONNELL.

Urbana, Ill.

319. CASEHARDENING PROCESS FOR COLD ROLLED STEEL.

To successfully caseharden common cold rolled steel so that it will answer for the cutters of inserted reamers, etc., pack the cutters in granulated raw bone in a cast iron box with at least one-half inch layer of bone between the cutters and the sides of the box. Put on an iron cover and lute with fire-clay; heat in a gas furnace to almost a white heat for from two to five hours according to the size of the box. Then draw the box, open and dump quickly into a bath composed of the following: 1 quart of vitriol (sulphuric acid), 4 pecks common salt, 2 pounds saltpeter, 8 pounds alum, 1 pound prussiate potash, 1 pound cyanide potash and 40 gallons soft water.

S. Pittsburg, Pa. F. WACKERMANN.

320. ETCHING ACID.

I have noticed in MACHINERY a number of times receipts for etching acid to be used on steel. These receipts mostly call for two-thirds muriatic acid. I find that the object of the muriatic acid is simply to remove the grease and foreign substance from the steel, and that if only enough muriatic acid is used to accomplish this purpose, the etching acid will work better and quicker. I have used etching acid with muriatic and nitric acids in almost all proportions and have found none so good as two-thirds nitric to one-third of muriatic acid. In some cases I have had good success even with a less proportion of the latter ingredient. GEO. W. SMITH.

Marquette, Mich.

321. TO PICKLE BRASS CASTINGS.

An excellent mixture to use for cleaning and brightening brass castings is as follows: Two parts, by measure, of nitric acid, and three parts of sulphuric acid. To each quart of the acid mixture made up, add one pint of common salt and stir until dissolved. The solution may be held in any suitable receptacle, say, of glazed earthenware. It is only necessary to provide a vessel large enough for the immersion of the largest piece to be dipped. The pieces are simply dipped and removed at once, and then rinsed in clear water. This solution is intended only for cleaning and brightening the castings, and not for imparting any color. T. E. O'DONNELL.

Urbana, Ill.

322. PLASTER OF PARIS FOR PATTERN MAKING.

For experimental purposes and where but a few castings of medium and light weight are required, plaster of paris has many good advantages as a material for pattern making. It is light, it can be given a smooth surface, it is easily given any required shape and it can be added to indefinitely. While it is brittle, this is more than offset by the saving in first cost and the quickness with which the pattern may be prepared. Plaster of paris sets in from three to six minutes, but if for any reason it is desired to keep the mass plastic for a longer period, one drop of glue to a five-gallon mixture will keep it soft for a couple of hours. Plaster of Paris mixed with cold water has an expansion of about 1-16 inch to the foot when hardening. Should this be undesirable, mix with warm water or lime water and there is no expansion.

Middletown, N. Y. DONALD A. HAMPSON.

323. GOLD SOLDERS.

Gold solder suitable for 18-karat work: Gold, fine, 1 ounce; silver, fine, 144 grains; copper wire, 96 grains. (Troy weight.)

Suitable for 16 karat work: Fine gold, 1 ounce; fine silver, 144 grains; copper wire, 168 grains.

Suitable for 15 karat work: Fine gold, 1 ounce; fine silver, 240 grains; copper wire, 240 grains.

Suitable for 14 karat work: Fine gold, 1 ounce; fine silver, 300 grains; copper wire, 300 grains.

Hardest silver solder: Fine silver, 1 ounce; shot copper, 120 grains.

Best hard silver solder: Fine silver, 1 ounce; shot copper, 105 grains; spelter, 15 grains.

Medium silver solder: Fine silver, 360 grains; shot copper, 96 grains; spelter, 24 grains.

Easy silver solder: Fine silver, 336 grains; shot copper, 108 grains; spelter, 36 grains. H. D. SCHATTLE.

Syracuse, N. Y.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

W. J. B.—The piston rod of a 22-inch cylinder Corliss engine, being broken, had to be replaced. The new rod was turned to a diameter of 2 29/32 inches, the hole in the piston being 2 57/64 inches, or 1/64 inch less than the diameter of the rod. In order to shrink the piston on the rod, the former was heated to a dull red, but the rod refused to enter the hole. It was then turned down about 0.008 inch more, or half of 1/64 inch. The piston was again heated, but the rod still refused to enter. Upon measuring the hole of the piston when heated it was found that the hole was smaller when the piston was heated than when it was cold. Now, the question is what is likely to have been the cause of the hole in the piston being smaller when heated? Could the piston being hollow have anything to do with the matter?

A.—If any of the readers of MACHINERY have had any similar experience or think that they can satisfactorily explain this occurrence we should be glad to hear their opinion.

R. A. W.—A rod of ¼-inch Stubbs steel 24 inches long, annealed and coiled into an open helical spring 1½ inch inside diameter, 2 inches long, was given a spring temper and placed on a 1½-inch diameter round punch to act as a stripper; when compressed to about 1½ inch it was only strong enough to strip 1/16-inch aluminum when the punch was ground sharp and slightly concaved on the end. Another spring, open helical as above, made from No. 6 Brown & Sharpe round rolled spring steel wire ⅝ inch inside diameter, 1 inch long, mounted on a 17/32-inch diameter round punch and compressed solid, was only strong enough to strip 1/16-inch aluminum, the punch being ground sharp and slightly concave, as before. I would like some data from the experience of others which would enable us to figure accurately the spring pressure required to strip stock of different metals and thicknesses from punches of various diameters. We would use positive strippers, but could not do so in the case cited.

A.—The above question is submitted to our readers for answer. Anyone having data on this subject is invited to submit it for publication.

C. K.—Is it necessary to mix anything with cyanide of potassium when it is melted in an iron pot for use in casehardening? I have tried to melt some and instead of melting, it all dried up like flour and would not melt at all. What was the cause of the trouble?

Answered by E R Markham.

A.—The trouble referred to is probably due to the cyanide having been for some time exposed to the air and thus becoming "air slaked." I have used many tons of cyanide in various forms, but have always been very particular to keep it tightly sealed in cans, or some other receptacle excluding the air. When kept in this manner I have never had any trouble in melting it.

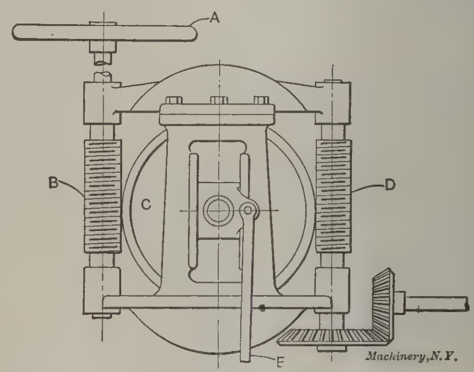
G. C. M.—Will the lead be the same in two pipe taps of the same size if one is chased with the taper attachment, and the other with the tailstock set over? The tool in both examples is to be set level with the axis of the work.

A.—No, but the difference is slight with the standard pipe tap, i. e., that having a taper of ¾ inch per foot. In the case of two pipe taps, one threaded with the taper attachment (good practice) and the other with the tailstock set over (bad practice), the number of threads in a length of 12 inches will be in the ratio of 12 to 12.006; assuming a lead of 14 threads per inch, there would be 168 threads on 12 inches axial length of the first tap and 168.084 threads on the second. Setting the tailstock over decreases the pitch, as measured on the axis of the tap. The pitch decreases with an increase of taper of the tap, and is inversely as the secant of half the included angle. For example, in the case of a standard pipe thread, half the included angle is 1° 47′ 23″ and the secant is 1.0005. Therefore, the ratio of the side of the tap to its axis is in the proportion of 1.0005 to 1, and the actual pitch to the apparent pitch is as 1 to 1.0005. If half the included angle were 31 degrees the secant would be 1.1666, showing that the taper side is one-sixth longer than the axis. Consequently, if a tap of this extreme taper were threaded with the tailstock set over, the axial pitch would be only six-sevenths of the pitch measured on the taper.

AN INGENIOUS SUBSTITUTE FOR THE FLOATING LEVER.

In the catalogue of an English firm building heavy metal-working machinery is shown, incidentally, a neat arrangement for performing the functions of the floating lever—a device generally used in waterwheel governors, steam steering apparatuses and other mechanisms in which it is desired to determine by sensitively moved levers, etc., the position of heavy parts requiring great power to shift their position. The advantage which the device shown in the cut would appear to possess over the floating lever is that its range is practically unlimited, so it may be arranged to control movements of great extent without sacrificing the compactness of the arrangement.

The handwheel *A* is the controlling element. It is connected with a worm *B* meshing with a wormwheel *C*. The shaft of this wormwheel is journaled in boxes which are free to slide up and down in vertical slides in the frame work which supports it. On the opposite side of the wheel is worm *D*, which is rotated by the heavy parts whose motion is to be controlled. Any vertical displacement of the wormwheel is transmitted to the rod *E* which operates the valve, belt shifter, clutch lever, or other device used for starting, stopping and reversing the driving machinery. Let it be supposed that the mechanism is



Substitute for the Floating Lever.

at rest with the wormwheel midway between its upper and lower position in the vertical slides of the housing, and the operator desires to locate the position of the heavy part whose movement is controlled by the arrangement; it may be a rudder, a waterwheel gate, or what not. He revolves the handwheel in a direction corresponding to the motion he desires. This rotates worm *B*, but as worm *D* is stationary since the mechanism is not yet in motion, the rotation of the handwheel has the effect of rolling the wheel *C* between the two worms, either up or down, depending on the operator's movements. The operator may rotate the handwheel to a position corresponding to the new adjustment he desires. The vertical displacement of the wheel just described will work the valve or clutch levers, and start the machinery in motion to bring to pass that new adjustment. As soon as a proper rearrangement thus started has been effected, the rotating of worm *D*, connected with the moving parts, will return the wormwheel to its vertical position and thus close the valve or release the clutch which made the movement possible.

* * *

Consul R. S. S. Bergh, of Gottenburg, in reporting on the Swedish experiments in making alcohol from peat, states that these experiments were started in 1903, the government and private persons jointly advancing the money necessary. It is claimed that satisfactory results have been obtained, especially as it has been found that the by-products of the process can also be sold. A company, Aktiebolaget Tourbière, has now been organized in Stockholm for the purpose of exploiting the invention. It is stated that the inventor thinks that the price of alcohol made from peat will be less than one-half of the present price of alcohol and lower than the lowest price of refined petroleum. This latter statement we must, of course, accept of with a certain amount of reservation, because experience teaches that what the inventor *thinks* is not always to be taken for granted.

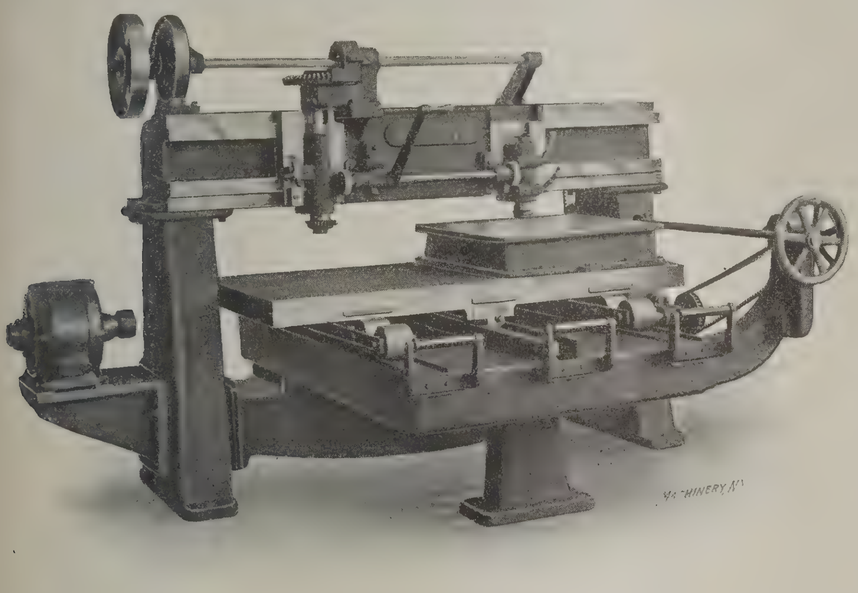
MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

AN UNUSUAL PROFILING MACHINE.

The machine shown below is designed for profiling the beveled edges of irregular shaped retort covers. While this is an operation somewhat outside of the regular run of work found in machine shops, the principle of the machine is exactly similar to that of the ordinary profiler; and it is so much heavier and of so much greater capacity than anything of the kind of which we have any knowledge, that it is a decidedly interesting machine. It has proved to be an eminently successful one as well.

To the cross rail, supported by the two heavy uprights shown, is mounted a carriage carrying at the right the former roll and at the left the cutter spindle. These two parts move longitudinally with each other owing to the fact that they are supported by the same carriage. Their vertical movement is also simultaneous; the bearings which support them are gibbed in vertical ways and may be raised or lowered together by the operation of the lever shown, which is connected to a rock shaft carrying gears at either end, meshing with racks attached to the two slides. The spindle is driven through bevel and spur gearing from a motor attached to a vertically adjustable bracket on the left-hand column; the vertical adjustment provides a means for maintaining the proper tension on the belt. For traversing the carriage on the cross rail, the handwheel at the right is provided, which, through the shaft extending to the rear of the machine, operates a sprocket driving a Renold silent chain, which in turn operates a pinion meshing with a rack attached to the carriage. This rack is double so that it may be adjusted to take up back lash due to wear. The chain has also a fine adjustment to insure constant and uniform motion between the hand-wheel and the carriage movement.



Profiling Machine for Large Work.

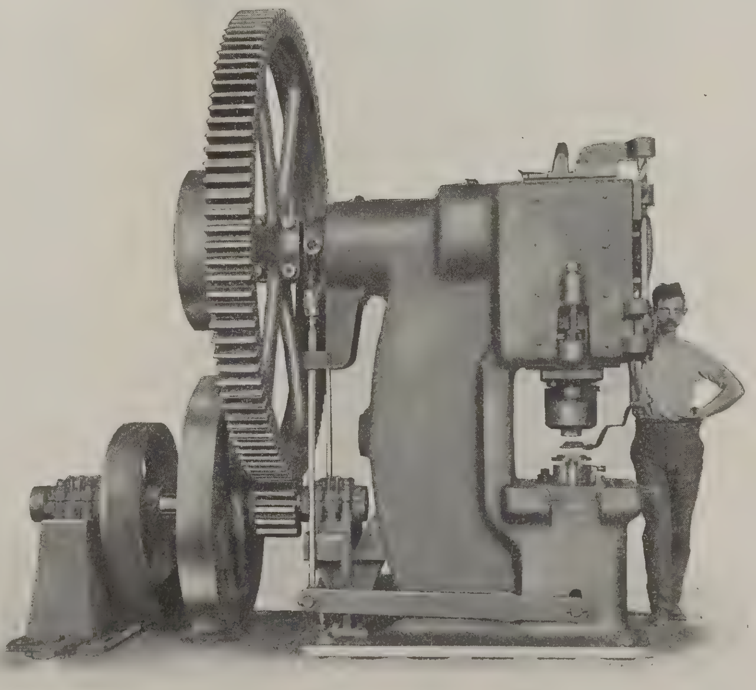
The work is supported on a broad table resting on a train of rolls on either side, which run in tracks provided for them in upper surface of the bed. This bed is supported at the rear by a cross rail between the two uprights, and at the front by a pedestal—thus giving a three-point bearing to the whole apparatus. For moving the table in and out a rack is attached to it, meshing with a pinion operated by a hand-wheel in a way similar to that just described for the carriage mechanism. This rack is also double and, as a means of alignment for the table and work, is confined in a planed groove or slide in the top of the bed. This rack slide and the two trains of rollers are protected from chips by canvas covers, not shown in the photograph. The table carries an auxiliary platen for the formers.

The distance between the centers of the spindles is 36 inches. The saddle has 36 inches of movement on the cross rails and the table has 40 inches of movement front and back. The table is 72 inches long by 36 inches wide, the distance between the uprights being 74 inches. The machine weighs about 11,000 pounds and was built by the Beaman & Smith Co., Providence, R. I.

A HEAVY WASHER PUNCHING MACHINE.

Some time ago (May, 1905, to be exact) we illustrated a press built by the Krips-Mason Machine Co., 1636 N. Hutchinson St., Philadelphia, Pa. This press was specially designed for the manufacture of washers with either single or multiple dies, and involves in its construction provision for stripping the work and the waste from both punch and die, and for presenting the stock to the cutting parts without injuring the operator. In the cut below we show a machine of the same type by the same makers, but of much greater capacity, it being possible with this tool to work ⅝-inch stock, and to blank out washers having a maximum outside diameter of 21 inches and a maximum inside diameter of 6 inches.

The punch is provided with a shedder and the die with a stripper, both positively actuated, the one by a cam on the rear end of the main driving shaft next to the gear, and operating through the system of levers shown, the other worked by a stationary adjustable bar passing through a slot in the ram. This system gives results similar to those obtained by the sub-press in small work so far as concerns the ability of the machine to use thin and delicate materials like paper, fiber, etc., and its ability to produce blanks from heavy stock perfectly flat and free from burrs or turned up edges. A carrier is provided for inserting work which has to be done piece by piece. This is in the form of an arm pivoted to a vertical shaft, rotated to right and left by the movement of the ram through the medium of helical grooves at the shaft's upper end.



Large Krips-Mason Press, Designed for Making Washers.

An important part of the business of the manufacturers of this machine consists in the working up of scrap metal into washers. This size is capable of making from 4 to 5 tons of such washers per day. The machine is geared in the ratio of 8 to 1, the main driving gear having a diameter of 8 feet and 8 inches face. The flywheel weighs 1,800 pounds, the total weight being 25,500 pounds. The builders have received orders for 12 machines of this size within the past six months.

THE WHITNEY JACK FOR POLISHING AND GRINDING.

It is not so many years ago since it was believed that all it was necessary to do in fitting up a polishing room, was to provide a number of wheels of various sorts, mount them on crudely constructed stands, and connect them with belts to a jack shaft on the floor. Scores of such rude contrivances were grouped in small rooms whose atmosphere was charged with floating metal dust, and whose space overflowed with the men, work boxes, machines, countershafts and flying belts which were crowded together in it. One of the first improvements consisted in providing exhaust fans for the wheels, thus serving to remove the dangerous metallic dust which did such damage to the workman's lungs. Besides that, some recent installations have shown evidences of forethought in the matter of doing away with unprotected driving mechanism. One of the most interesting of these plans is that incorporated in the Whitney "jack" shown below. While this device is here described for the first time, it has been tested out in actual use for something over four years, some manufacturers having had as many as 100 of them going throughout that period. Its builders, the New Britain Machine Co., of New Britain, Conn., assert that a definite and adequate mechanical reason exists for every feature of its design, and that its details have been arrived at by trial, elimination, and the survival of the fittest.

One of the first points noticed is that the belting runs downward to a line shafting beneath the floor. By doing this, opportunity is afforded to dispense with countershafts, clutches and loose pulleys, and thus at the outset relieve those in charge of the machines of several notorious sources of trouble in high-speed machinery. This method of connection, pulling the shaft, as it does, down into its bearings, insures a steady true running wheel. The belt is carried inside of the case as shown by the dotted lines in Figs. 1 and 2. This entirely encloses it from its greatest enemies, oil and dust, and also protects the surrounding air from the currents which would otherwise be set up by the rapidly moving parts, thus lessening the amount of loose emery floating around in the air. The lever shown in the front of the machine is lowered in Fig. 2 and raised in Fig. 1. In Fig. 1 with the lever raised the spindle is dropped and the belt hangs slack, stopping the machine; this extends the working life of the belt and relieves both the bearings of the jack and those of the lineshaft from the pressure due to the tension of the belt. When the handle is depressed the spindle is raised, as shown in Fig. 2, and the belt is in position for operation. It can be readily reached for examination, and provision is made for tightening it without relacing. The weight of the heavy wheels, bearings, etc., is usually enough to hold the top down at all times onto the starting handle, but when such work as sad irons are being polished, under the pressure of a lever beneath the wheel, an up-stop is provided to lock the top.

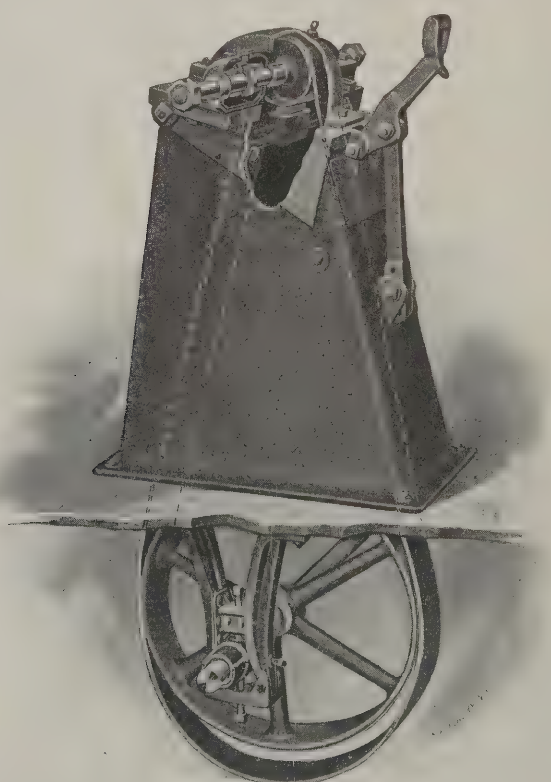


Fig. 1. Whitney Jack with Belt Slacked and Spindle Stopped.

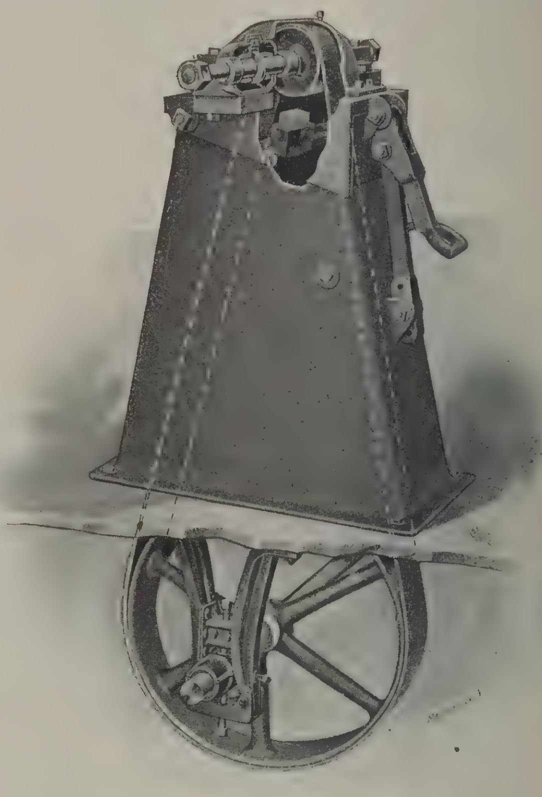


Fig. 2. The Head Raised to Working Position.

The spindle is of high carbon steel, with a special form of threaded end which tends to prevent the accumulation of emery at this point. The pulley is crowned according to the system in vogue in the shops of the builders, and described in a letter by Mr. Gauthier in the September, 1905, issue of Machinery. This system, in the belief of the builders, gives the maximum tractive effort at high speed, with a true running belt and a comparatively small amount of center stretch. A double seal is provided against the intrusion of emery in the bearings. The important matter of lubrication is attended to by a reservoir of oil for each bearing, this oil being used over and over again. Speeds up to 5,000 revolutions per minute have been attained and maintained on this machine. The table given below, furnished by the makers, will give a general idea of suitable speeds for wheels of various kinds and varying diameters:

Diameters.	12 in.	14 in.	16 in.	18 in.	20 in.
Solid emery wheels........	1750	1500	1315	1165	1050
Leather covered polishing wheels	2700	2320	2030	1800	1620
Disk grinders (steel disks)	2700	2320	2030	1800	1620
Cloth buffing wheels.......	3980	3410	2985	2655	2390

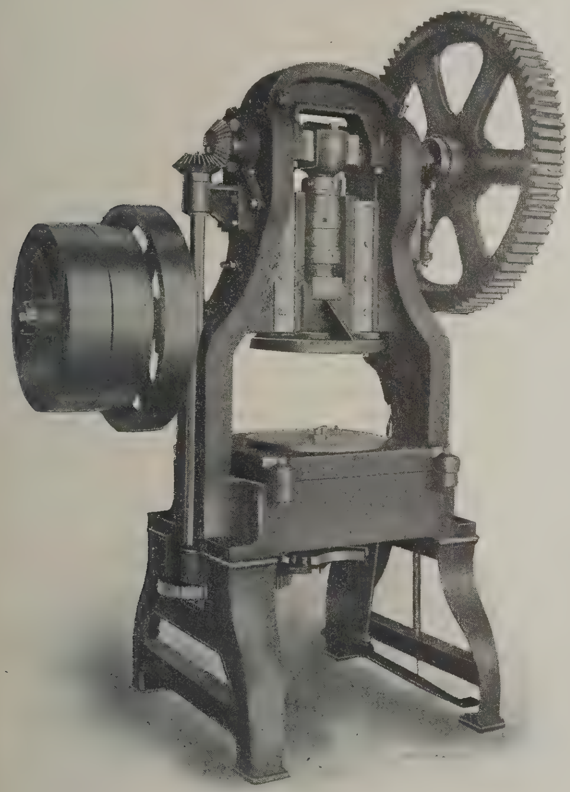
Any desired form of windgate or hood may be attached by the purchaser; the makers have patterns for a number of different styles of them.

BLISS SPECIAL DIAL FEED PRESS.

The principal interest of the machine shown in the cut lies in the feed arrangement. A bevel gear on the end of the crankshaft meshes with a gear on the vertical shaft at the

left hand side of the machine. This, in turn, carries a spur gear at its lower end which drives a similar gear beneath the bed of the machine, the latter being connected to the mechanism known as the "Geneva stop motion." This device is too well known to require detailed description. It will be remembered that it provides a means for indexing a shaft or dial rapidly and easily, and then locks it in position for a longer or shorter space of time before again indexing it as before. In this use of the mechanism a further positive lock is provided which renders the location of the dial absolutely positive.

The machine is operated in an interesting manner. A large flanged bottom face is provided for the slide. To this four



Cutting and Forming Press with Ingenious Feed.

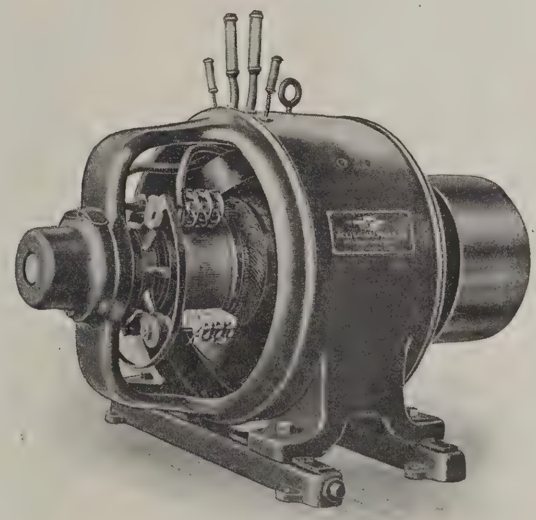
punches are fastened—a cutting and forming punch in front, and a similar cutting and forming punch in back. The dies are bolted to the dial plate. One operator stands in front and another at the back of the machine, each holding a piece of the material which is to be cut and formed. Passing the metal under the blanking punch, the blank is cut out and is then, by means of the dial plate, carried under the forming die, whence it is automatically ejected and brushed aside. Thus two duplicate pieces are produced at each stroke of the press, and since the machine runs at 60 revolutions per minute, the total product is 120 complete pieces per minute, involving 240 operations in that time. From this it will be seen that the machine is adapted for producing articles requiring a cutting and forming operation, when such articles have to be made in large quantities. The total weight of the machine as shown is about 6,200 pounds. It is built by the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y.

ALLIS-CHALMERS MOTOR FOR INDIVIDUAL DRIVE.

The Allis Chalmers Co. of Milwaukee, Wis., have recently developed a new type of motor for direct connected service; one of this line is shown in the cut herewith. The requirements for which this motor has been designed are those due to the growing application of individual drives to machinery of various kinds. Motors used for this service must not only be compact, but they must, as well, be adapted to mounting in any position, while the windings and commutator should be so arranged as to be partially or wholly protected from injury where such protection is required. Geared and direct coupled methods of driving are rapidly displacing belts, and this, together with the fact that strains and overloads are of common occurrence, requires larger bearings than are commonly used in motors of this class. Great improvements have also been necessary in the matter of commutating qualities, since present requirements call for wide variations in speed with occasional heavy overloads.

The field magnet yoke is of open hearth steel, machined to receive the bearing housings, which are held in place by through bolts and can be rotated through 90 or 180 degrees. The pole cores are of open hearth steel, circular in cross section, with pole shoes having faces of such shape as to give suitable distribution to the field flux, give good commutation, and prevent humming due to the armature teeth. The armature core is ventilated and the coils are form wound. The commutator is of large diameter to give a good wearing depth, with the mica between the bars so selected as to give an even wear. The shaft is lubricated by the ring oiling system. The projection for the pulley is turned down smaller than the journals, so that the latter may be trued up when worn without reducing their diameters below that of the pulley bore.

In the use of variable speed motors for the individual drive of machine tools, there are two points to be carefully considered: First, the size and weight of the motor is dependent to a great extent on the minimum speed at which the motor is required to develop its full rated power; the slower the minimum speed, the greater will be the size and weight for a given horsepower output. Second, the maximum speed of the motor is dependent on the allowable peripheral speed of th armature, commutator, and pinion or belt; or upon the ratio of speed reduction between the driven shaft and the motor shaft. This limits the maximum speed to 1,000 or 1,600 R.P.M. depending on the output of the motor. The maximum speed being thus fixed by mechanical limitations, any increase in the range of speed variation must be obtained by decreasing the minimum speed and consequently increasing the size



Allis-Chalmers Type K Motor.

of motor for a given output, or decreasing the output for a given size. These mechanical limitations make it desirable to keep the speed range down to a reasonable amount and in Type "K" motors it has, therefore, been limited to a ratio of 3 to 1.

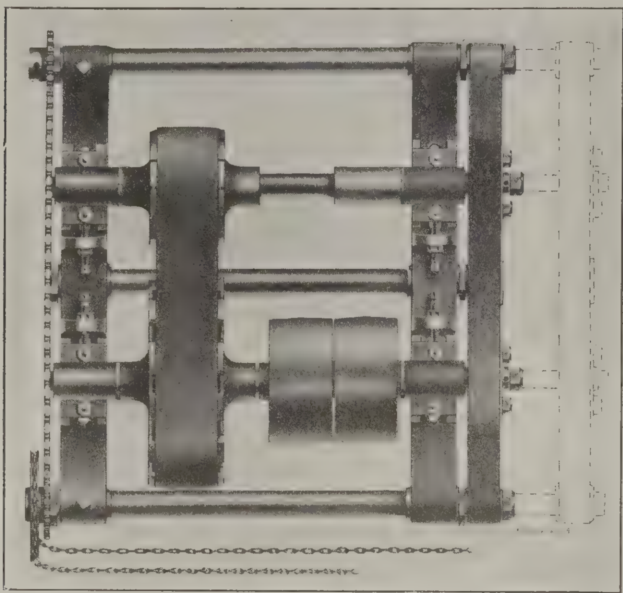
These motors are manufactured in thirteen different frame sizes, and for each size there are a number of ratings, the output of a given frame being proportional to the speed.

THE S. AND S. VARIABLE SPEED GEAR.

The S. & S. Engineering Co., 581 Park Place, Brooklyn, N. Y., are selling in this country the interesting variable speed device shown in the accompanying cut. This appliance has been built and used for a number of years in England and Canada, and is therefore not in any respect untried.

The device is of the expansion pulley type, so designed as to make possible an efficient short drive without depending on the sag and elasticity of the belt. Power is received by the shaft carrying the tight and loose pulleys. Both of the shafts are hollow and each contains a rod connected to the cross bar

shown at the right hand end. This cross bar may be moved in and out, between the two extreme positions shown by the full and dotted lines, through the action of two screws, located in the outer tie bars and connected to each other by the sprockets and chain shown at their left hand ends. Any suitable connection may be made for operating these screws in a convenient manner. The rods within the shafts have formed on their inner ends spiral grooves which engage with similar spiral keys in pinions seated within and concentric with the axis of the two expansion pulleys. Rack teeth are formed on the supporting arms of the separate sections of the expansion pulleys; these rack teeth mesh with pinions just described, so that, as the cross bar operated by the sprocket wheels and screws is moved in or out, the spirals on the end of the rods rotate the pinions, which in turn withdraw or extrude the sections of the expansion pulleys, in such a way as to increase the diameter of one and diminish that of the other. The change in velocity ratio thus obtainable is approximately 4 to 1.



Variable Speed Device, utilizing the Expansion Pulley Idea.

No special belts are necessary, and all the pulleys used are between the bearings, thus at once economizing space and reducing the strain on the mechanism. This variable speed gear may be mounted on ceiling, wall or floor. The bearings are of the best phosphor bronze, and, excepting in the cases where the mechanism is installed on the floor, are all lubricated from magazine oil boxes which only require attention about once a month. The heaviest machines and those intended for floor positions are ring oiled. The horsepower transmitted by various sizes ranges from as small as 2 to as large as 128. The latter size employs 40-inch diameter by 24-inch face pulleys, running at a maximum speed of 120 revolutions per minute.

PRATT & WHITNEY 16-INCH TOOLMAKERS' LATHE.

The members of the line of lathes manufactured by the Pratt & Whitney Co., Hartford, Conn., have an individuality in their lines and proportions, and an originality in their mechanical design, which makes them singly, or as a whole, well worth the attention of the designer or the machinist. The latest addition to this line—a 16-inch toolmakers' lathe—is no exception to this rule, as our readers will admit after examining the accompanying halftones and following the description given below. Being designed for high class manufacturing, it must have all the improvements to be found in modern engine lathes, including the ability to take heavy cuts with high speed steels; and yet, since it is to be used for delicate work, the machine must still be sensitive in all its movements and convenient to handle. This is a difficult problem. Its proper solution requires a careful distribution of weight, and a proper proportion between the areas of the sliding surfaces and the pressure which has to be carried by them.

Of the two types built, the single belt gear-driven machine is shown in Fig. 1, while Figs. 2 and 3 show a 4-step cone-driven machine. The geared head is designed to give eight speed changes, obtained entirely by the action of friction clutches of sufficient power, manipulated by the three handles shown. This arrangement, while furnishing a powerful drive, still permits all the changes to be made while the lathe is running at full speed, even for the heaviest cut the tool is capable of taking. The highest and lowest speeds can be obtained instantly. When the motor drive is desired, a constant speed motor is mounted on the top of the headstock and geared to the pulley spindle. The spindle has bearings of unusual dimensions. Faceplate, chucks, etc., are attached to its nose by the well-known method employed by the builders, a taper seat being used in combination with a coarse pitch screw for drawing the parts together.

The feed and thread cutting changes are obtained by a rapid change gear mechanism which has 48 combinations, operated by the two knobs shown at the front of the gear box. A plate is here displayed giving tables and formulas for cutting irregular pitches, which may be obtained by change gears in the ordinary manner. When cutting threads it is not necessary to reverse the spindle, since the screw is reversed by the manipulation of the lower knob at the front of the apron. A rod runs the whole length of the machine and on this are placed adjustable stops, so that an automatic cut-off is obtained in either direction for either thread cutting or turning. All feeds may be disconnected by turning the knob shown under the rear bearing.

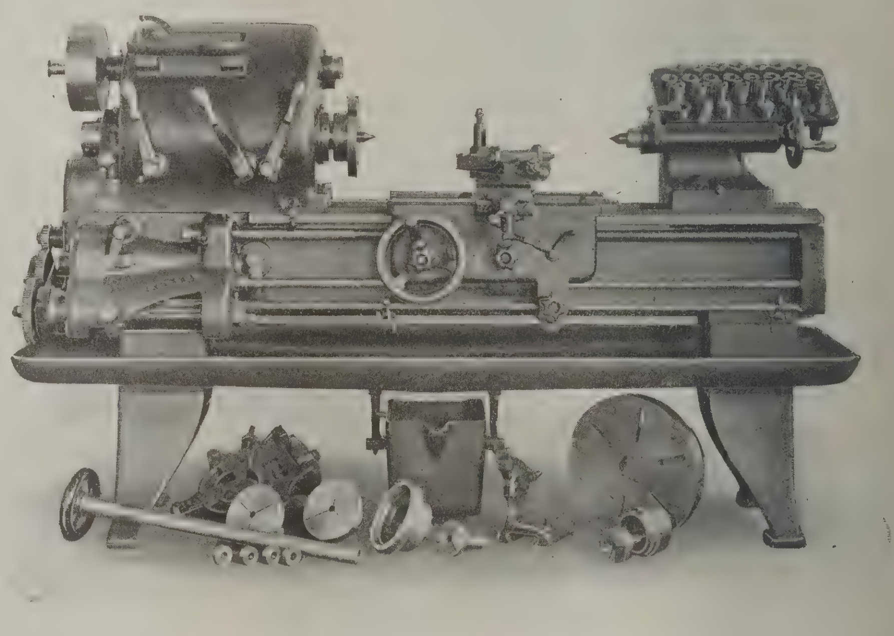


Fig. 1. Front View of Pratt & Whitney Single Pulley Gear-driven Lathe.

A new feature of the lathe is the quick withdrawing mechanism provided for the cross slide. This is best shown in Fig. 3. Below the handle for the cross slide screw will be seen a short lever pivoted to a vertical axis. This lever is used in withdrawing the tool when threading, for either internal or external threads, the feeding in for the new cut being obtained by altering the adjustment of the cross slide screw in the usual manner. To bring the tool into engagement with the work again, the handle is thrown to the right-hand stop for external threads and to the left hand stop for internal threads. This movement is very rapid in operation and is thoroughly rigid, although sensitive and accurate. The compound elevating rest is also a new idea. The operator can set and fasten a thread tool, for instance, square with the

spindle, and then elevate it without loosening it in the toolpost.

The machine may be provided with a large variety of attachments. The taper attachment has only one sliding point in the whole mechanism, and can be adjusted without wrenches. The relieving attachment, best shown in Fig. 2, is especially efficient. In the tool board, supported back of the tailstock in Fig. 1, will be seen a set of expansion arbors and bushings which are very convenient for work which has to be exceptionally accurate. A series of collets for work up to 1¼ inch in diameter is also provided, while special step chucks may be used with short work up to 6 inches in diameter. Another attachment of great utility is the micrometer stop shown clamped to the front edge of the bed near the forward headstock bearings in Figs. 1 and 3. This is a great convenience in squaring up work to a given thickness. It may be used for either side of the carriage. Another use to which it may be put is that of bringing back the carriage without stopping the spindle when cutting threads. The half nuts are thrown out after the lead screw has been stopped on the lathe, and the carriage is brought back by hand against the stop; the half nuts are then thrown in, the stop being adjusted so that they will always catch the right thread.

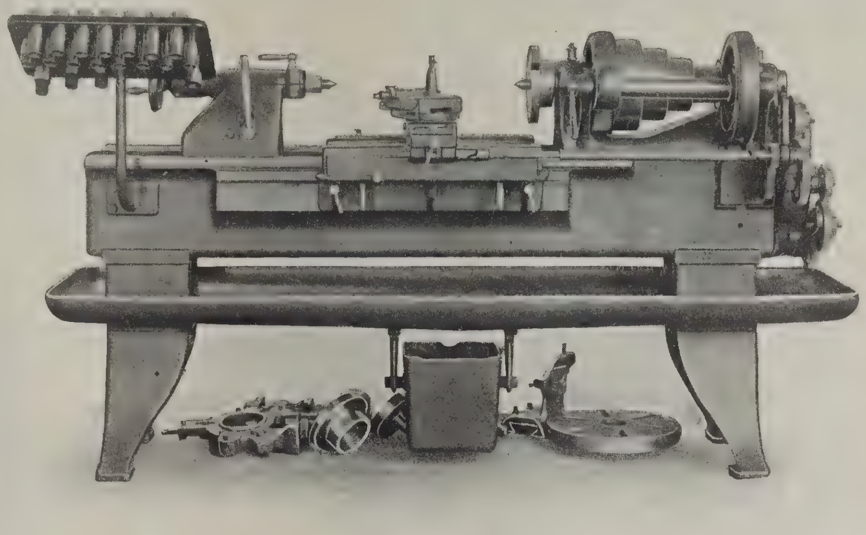


Fig. 2. Rear View of Pratt & Whitney Cone-driven Style Lathe, showing Relieving Attachment.

The general lines and proportions of the machine are familiar, since they follow those of the other lathes built by the same firm. The courageous use of unfinished surfaces wherever finished ones are not needed, and the rational and pleasing design of the larger castings, gives a combined effect

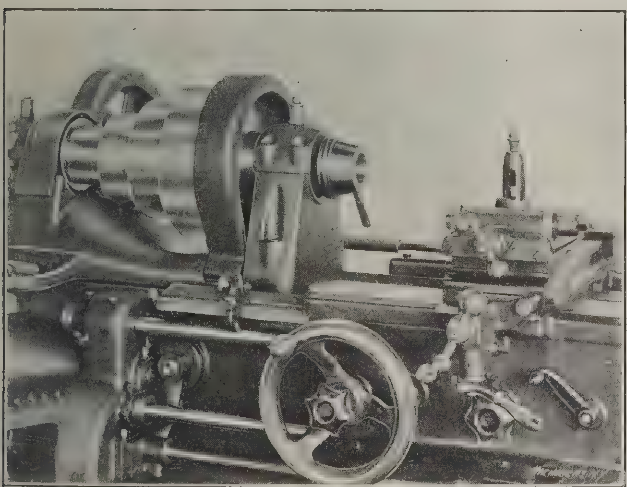


Fig. 3. Quick Withdrawing Mechanism, Micrometer Stop, Elevating Toolpost, Etc.

that to some eyes, at least, is as pleasant and satisfactory as anything built of iron and steel for commercial purposes can be.

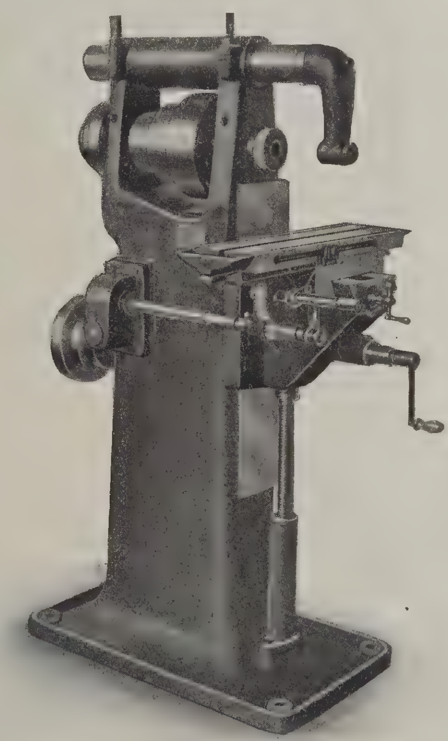
The lathe swings 16¾ inches over the V's and 10 inches over the cross slide. It is built in 6, 8 and 10 foot lengths. The lathe, as illustrated in the photograph, is provided with oil pan and tank, but it can also be furnished without these. An oil pump and piping will be furnished when desired. The lathe is also built with metric screws and metric gear boxes, though metric threads can be cut with English screws by using translating gears.

WAINWRIGHT & KELLEY PLAIN MILLING MACHINE.

In the plain milling machine shown in the cut, Wainwright & Kelley, of Trenton, N. J., have designed a tool to fill the requirements of makers of electrical goods, sewing machines, brass goods, and other manufacturers requiring a machine of medium range, but of great stiffness and accuracy. Besides the qualities just enumerated, attention has been given to reducing the amount of mechanism required to the lowest degree, so that the machine, as may be seen from the cut, is one of extremely simple construction.

So far as the main outlines of the tool are concerned, it conforms to the standard column and knee type. The column is very heavy for its size, and is so designed as to effectually absorb the vibration set up by the cutter. The knee is of the enclosed box type, reinforced to withstand side strains, and with an ample bearing on the column face.

The spindle is of hammered crucible steel 0.40 carbon, running in self-centering adjustable bronze boxes. The arbor hole is fitted to a No. 9 Brown & Sharpe taper. The arm is 3 inches in diameter and carries an arbor bushing of hard bronze, also adjustable for wear. The table has a working surface of 25 inches x 6 ⅛ inches, with a central T-slot and suitable pockets and channels for taking care of the cutting oil. The feed is operated through a rack and pinion, driven by worm gearing enclosed in the casing at the left of the machine. A quick return is provided. The feed is driven through a patented clutch, designed to be operated by an ad-



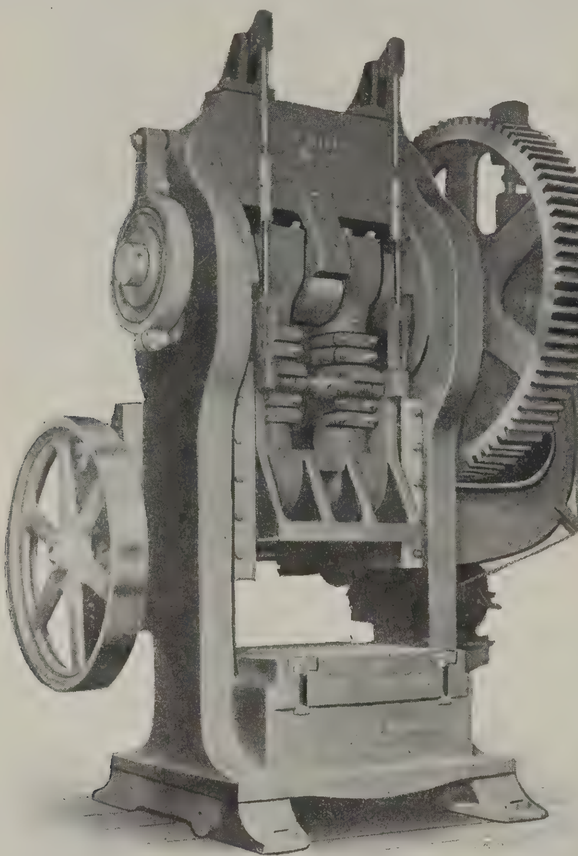
Plain Milling Machine for Light Manufacturing.

justable dog for determining the length of the feed. Adjustable dials graduated to thousandths of an inch are provided for the vertical and transverse movement of the table.

The lengthwise cross, and vertical movements of the table are, respectively, 18 inches, 4½ inches and 13 inches. The three-step cone is driven by a 3-inch belt. The net weight of the machine is about 1,100 pounds.

TOLEDO DOUBLE BACK GEARED PRESS.

The machine shown in the halftone below was designed for the hot pressing and forming of couplings for oil pipes and similar work, as well as for cold pressing. It is double back geared, has a double pitman, and is motor driven. The frame is a one-piece casting weighing 29,000 pounds. The clutch

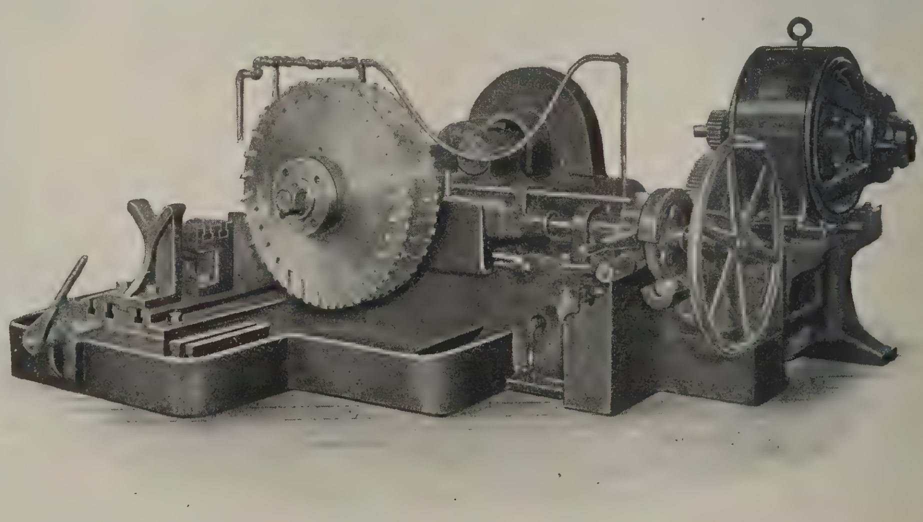


Toledo Double Back Geared Press.

mechanism is of the three-engagement automatic block type with gravity releasing device—a form specially suited for heavy presses, it being very powerful as well as simple in construction and positive in action. The 20-horsepower motor used is conveniently placed on the right hand side at the rear. The crankshaft is 9 inches in diameter. The large gear is 85 inches in diameter by 12 inches face; the flywheel is 60 inches in diameter, while the distance from the floor to the top of the large gear is 11 feet 8 inches. The distance from the bed to the slide, with stroke and adjustment up, is 30 inches, the length of stroke being 8 inches. A bed area of 6 inches right to left by 48 inches front to back is provided. The total weight of the machine is 73,500 pounds. It was built by the Toledo Machine and Tool Co., Toledo, O.

MOTOR-DRIVEN ROTARY SLOTTING MACHINE.

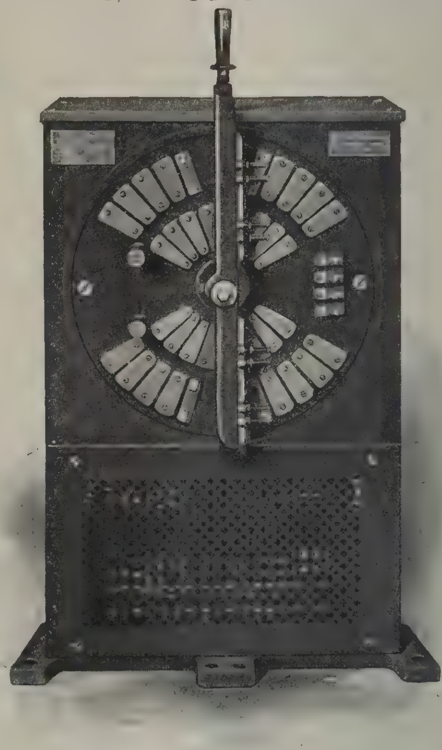
The halftone shown herewith illustrates a specialized form of cold saw, recently built for the Union Pacific R. R. Co. by the High Duty Saw & Tool Co., of Eddystone, Pa. It consists essentially of two saws mounted on the same spindle at adjustable distances apart, together with means for setting the saws into the work which is held by suitable clamps and fixtures on a table prepared for it. The machine is intended to be used in slotting forged steel cranks, connecting rods, links and similar pieces. By removing one of the saws it can be used as a regular cut-off machine on axles and miscellaneous straight stock.



Cold Saw for Slotting Cranks, Connecting Rods, Etc.

The machine is electrically driven by a 15 H.P. direct current motor, having a speed change ratio of two to one. The connection between the motor and the saw spindle is by positive gearing of the spur and bevel type, it being the belief of the makers that worm gearing is unsuited for this purpose, owing to its high friction loss and the wearing out of the costly wormwheels. The slide on which the saw is carried has a large bearing area on the table and is made with the underlock cast solid. Phosphor bronze taper shoes take up all the wear on the saddle or table.

A removable table with a screw adjustment for setting work in line with a spindle, is a feature of the machine. Special V stands and rest blocks with suitable clamps and bolts are provided; these fixtures are all removable, leaving the table clear for bulky work. Pipe and piping are also supplied for pro-



A Controller Specially Designed for Crane Service.

viding the saws with lubricant. The machine will cut double slots to a depth of 11 inches and spaced up to 10 inches apart, in steel as hard as 0.45 point carbon. The machine in ordinary service cuts a slot of these dimensions in fifteen minutes.

A NEW LINE OF CONTROLLERS.

The Electric Controller & Supply Co. of Cleveland, Ohio, have recently completed the design of a line of controllers with a rating of from 1 to 50 horsepower. This line they have designated as their "Type G." These controllers are built to meet the requirements of general crane service where the conditions are not severe enough to demand the use of

the Dinky ventilated style. Besides being mounted and used in the ordinary way in cases where the crane has a cab and permanent attendant, they may be arranged with spring return for operation from the floor, by means of pendant ropes or chains. This construction is designed to meet the requirements of crane users who have decided that cranes no larger than 15 to 20 tons capacity, with 25 to 30 horsepower motors on hoist and bridge motion, may be operated from the floor by any of the men in the shop, thus saving the wages of a crane operator who would probably be idle half the time. When used in this way, special cut-outs are arranged for the current at the end of the trolley run and at either end of the crane track.

Type "G" controllers are self-contained, compact and accessible. They are all made with jigs, fixtures and other special tools which make their parts interchangeable. The segments are of copper, screwed to brass lugs, to which all wiring connections are made; this allows the contact segments to be removed and replaced without disturbing the wiring. The contact fingers, of drop forged copper of great hardness, may also be removed and replaced without removing the contact arm. An effective blow-out is provided in all sizes.

A DOUBLE PULLEY LATHE OF LARGE CAPACITY.

The machine shown in the halftone is a specialized lathe built for machining pulleys up to 8 feet in diameter by 72 inches face; the machine is double and it will finish two such pulleys at a time. The spindle is driven by a large wormwheel keyed to it midway of its length, the worm being driven by a 40 horsepower motor. Each end of the spindle carries a faceplate for supporting and driving the work. To the extended base on either side are clamped two tailstocks, adjustable in or out to suit the length of the arbor used when the pulleys are turned on centers. The machine is open at the back so that pulleys can be swung in without meeting any obstruction.

Two toolposts are used on each side. They are held by slides which have a longitudinal power feed on the cross rails. These cross rails are supported by the permanently fixed brackets shown, and may be moved in or out on them by means of adjusting screws at each end of each rail, each pair being connected together by bevel gears and a transverse shaft, operated by a ratchet lever. This adjustment is not used in feeding, the rail being moved in or out to roughly suit the diameter of the pulley; the depth of cut and the facing of the rim are regulated by a cross feed in the tool rest. The feed of the two toolposts on each rail, lengthwise of the pulley, is positively operated by the gearing on the outside end of each cross rail. An automatic crowning device is used whose guide bar may be seen mounted on the front edge of the cross rail. This machine was built by the Pittsburg Machine Tool Co., Allegheny, Pa., and weighs 50 tons.

* * *

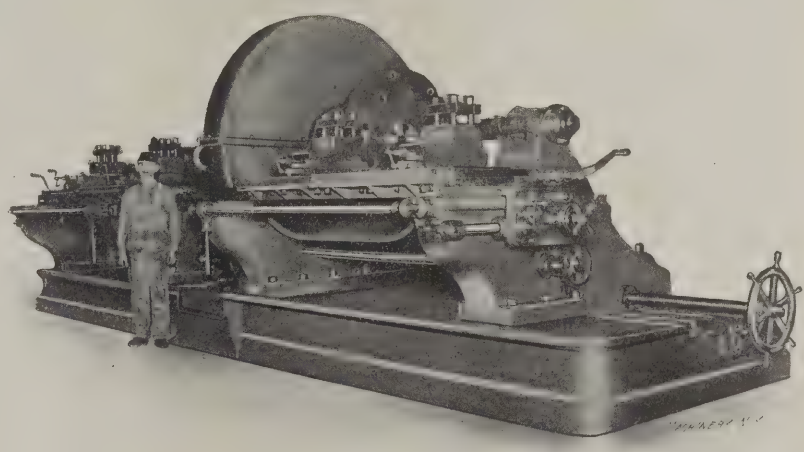
Secretary Taft has just rendered his decision upon the applications under the Burton Act for the issuance of permits to divert water for power purposes from the Niagara Falls on the American side, and for permits to carry electrical current developed from water power on the Canadian side into the United States. The Secretary decides that with the diversion of 15,600 cubic feet per second on the American side and the transmission of 160,000 horse-power from the Canadian side, the scenic grandeur will not be effected substantially or perceptibly to the eye. If Mr. Taft's contention in this respect is correct there is, of course, no objection to making use of the enormous power of the falls, but it must be remembered that there is nothing that can be considered to belong to the nation as a whole any more than do these water falls. It is deplorable that their exploitation will in all likelihood merely be profitable to a few corporations of more or less monopolistic nature, instead of enriching the nation as a whole, which would be the correct and the desirable end of their conversion into industrial use.

EUROPEAN INDUSTRIAL NOTES.

TRADE CONDITIONS IN GREAT BRITAIN.

Present indications point to a continuance, during 1907 at least, of general briskness in trade. The returns of exports and imports recently issued record a period of unexampled expansion of British commerce during 1906. It has, however, recently been pointed out that the increased prices of most raw and semi-finished materials cause a certain dislocation of general values, and if great caution is not exercised a big output at high prices will not necessarily show greater net profits than a smaller output when medium, all-around prices prevail. The price of copper, for instance—about 25 cents per pound in January—hits many manufacturers very hard, as prices for their products cannot readily be raised in the same ratio. Similarly, one daily newspaper notes that the ordinary "man in the street" finds little increase in salary or wages. There is, of course, greater steadiness in the unskilled and semi-skilled labor market, but the skilled artisan finds a wage advance of from 25 cents to a dollar weekly about as much as he can reckon on, while the clerk in general simply deals with larger figures in his books but feels no personal benefit. At the same time, increased prices of food, rents, etc., pretty well balance current salary or wage advantages. Perhaps it is well to occasionally take some cognizance of such aspects of industry.

Practice changes or advances so rapidly nowadays that it is



Double Pulley Lathe built by the Pittsburg Machine Tool Co.

difficult to realize that it is scarcely more than nine years ago that the question of relative merits of cast *versus* cut gears was being discussed with some little dogmatism in this country. The matter was somewhat complicated by the fact that cast gears of such general truth and finish that they were easily equal or superior to many specimens of what purported to be cut gears, could, over here, be obtained without any particular difficulty. The argument of the extra strength and endurance of cast teeth which retained their hard skin was freely brought forward, but for some years now the many indirect advantages of cut gears, coupled with the considerable diffusion of modern types of gear cutting machines, and the force of customers' demands, has practically made the use of cut gears on machine tools, and many other machines, universal. Several firms have laid themselves out with a direct view to meet the large demand thus created, and in this connection we may make mention in particular of David Brown & Sons, Huddersfield, who, as a development from a well-established business of general pattern making, have gradually added gear making and cutting to such an extent as to necessitate the building of a large and modernly designed and equipped works solely for the latter purpose, large gears and speed reducing gears in general being rather a specialty with them. Smaller concerns also make a good showing and find their plants well employed. American makes of automatic gear-cutting machines early obtained a strong footing, due partly to their intrinsic merits, being first in the field, and to being generally of thoroughly high

grade workmanship. Several British makers, of which Darling & Sellars, Keighley and Parkinsons, Shipley, are representative, are now turning out machines giving a high output —on British gray iron—coupled with designs which appear likely to ensure extended satisfactory life. The hobbing of spur gears is also making some progress, Continental makers being prominent in offering machines adapted to this method of production, though John Holroyd & Co., Manchester, are also turning out machines capable of handling gears up to the largest diameters in general use. Concerns who have given attention to bevel gear planers include Smith & Coventry, Ltd., Manchester, and Greenwood & Basley, Ltd., Leeds.

Drilling machines of all kinds have, during the last few years, received considerable attention. Not only has the general standard of strength, power, and handiness been raised, but one or two new types have been evolved. Messrs. Archdale, of Birmingham, have been active in the design and production of small radial drills from 30 inches radius upward, which combine the advantages of the upright drill press with the range of a radial. They are efficient both as sensitive drills and as exponents of the possibilities of high-speed twist drills. Their success has induced sincere praise. In the medium and heavy lines of radial and upright drills many good examples may be quoted both of the all-gear and cone pulley drive types. Among typical makers may, perhaps, be mentioned Kendall & Gent and Hetherington's, Manchester; Swift, Halifax; Buckton, Leeds; Shanks of Johnstone, etc., Features which not very long ago would have been considered as pandering to indolence or ultra-refinement are now included almost as commonplace. The medium and sensitive types of upright drills have not been neglected, several concerns now turning them out on lines suggested by the best American practice, and in design, finish, and price they are able to compete on level terms with any other build.

Agricultural engineers have recently considerably strengthened their position as regards ability to compete in neutral markets, special attention being paid to the requirements of foreign users. At present many designs are probably on the heavy side rather than the light, but it must be remembered that a very good market exists in this country for substantially built machines which are properly used and kept by the owners and care is being taken not to spoil one market in efforts too keenly directed toward gaining others.

Shipbuilding capacity in Great Britain, both from the mercantile and naval standpoint, has greatly increased during the last few years. Large Sheffield ordnance makers have acquired shipbuilding facilities, and, similarly, shipbuilders have working arrangements with complementary firms, so that warships may be constructed and equipped throughout by contract with a single company. The speed of building ships has been remarkably accelerated, both in government and private yards. The government especially has been active in improving its engineering and shipbuilding equipment. The first keel plate of the new battleship *Temeraire*, of the *Dreadnought* class, was laid down at Davenport on January 1 of this year, the ceremony being of an absolutely private character. Important extensions and improvements are now being effected at the Elswick shipyards and works and also at the Openshaw (Manchester) works of Armstrong, Whitworth & Co. The shipyard is being entirely remodeled, with a view to the construction there of the heaviest armor-clads, such as the present naval policy foreshadows will be adopted by all great naval powers in the future. Several of the building berths are being lengthened and improved and, most important of all, an entirely new armor-clad berth is being put down at the east end of the yard to take vessels up to 700 feet long and of the heaviest displacement. The new berth which will be used for the construction of the *Superb*, one of the three new *Dreadnoughts*, which is to be built by Armstrong, Whitworth & Co., will be able to carry a vessel of over 30,000 tons, which is nearly twice the launching weight of either the *Lusitania* or the *Mauretania*, the largest vessels yet built.

JAMES VOSE.

Manchester, January 25, 1907.

[Last year the tonnage of ships launched in British yards reached the total of more than 2,000,000 tons, which is the highest on record.—EDITOR.]

MISCELLANEOUS FOREIGN NOTES.

THE OBERSCHLESISCHE EISENINDUSTRIE A. G. in Germany have decided to introduce the manufacture of tool steel in the electric furnace on a large scale. The Kjellin inductive furnace will be used; the installation will be made by the Siemens & Halske A. G., Berlin, Germany.

J. PARKINSON & SON, Shipley, England, have placed on the market a new horizontal boring machine. The bed is 15 feet long over all; the spindle is 4 inches in diameter, and bored to receive a No. 6 Morse taper; sixteen spindle speeds are obtainable and eight rates of gear feed, ranging from 0.012 to 0.25 inch per revolution of spindle. The work table is 3 feet by 4 feet. The maximum distance from the top of the table to the center of the spindle is 32 inches, and the minimum 3½ inches. The machine is driven by a 4-inch belt applied to a four-speed cone.

THE WOLSELEY TOOL AND MOTOR CAR CO., LTD., Birmingham, England, have placed on the market a boring machine head having two spindles for use in boring twin cylinders and work of similar requirements. The centers of the spindles can easily be adjusted in relation to one another. One spindle is driven direct from the boring machine by a suitable coupling, while the other is driven by a train of gears. The maximum center distance is 6, the minimum 4 inches. Scales in the front of the head give the exact center distance obtained by any one setting.

GERMAN EXPORTS AND IMPORTS OF MACHINE TOOLS. For the nine months, January-September, 1906, the exports of machine tools from Germany amounted to 33,000 tons, of which somewhat more than 500 tons were exported to the United States. The imports amounted to 7,100 tons, most of this, or nearly 5,000 tons being American machine tools. There is some hope in Germany that some tariff arrangements will be effected with the United States so as to, in the future, even out the balance of exports and imports of machine tools in regard to this country to a greater extent than at present.

THE NEW ZEALAND EXHIBITION.—The Christchurch Exhibition which was opened during the latter part of last year has been well patronized, steamers from Australia having brought over very large numbers of visitors and business men. America's interest in the exhibit has been exceedingly small, which probably is due to the fact that there is at present no pressing need of new markets. In the future, however, it is likely that New Zealand and Australia will both become of importance to American trade, particularly after the opening of the Panama Canal, when the trade in Australia from the eastern part of the United States is likely to receive a great impetus.

THE OWNERSHIP OF MACHINERY IN FACTORIES IN GERMANY.—We mentioned in our foreign review last month that the consular reports from Germany indicated that the imperial court held that machines in a factory became fixtures and could not be claimed by the firm having furnished them, no matter what would be the particular condition of sale in each individual case. We also mentioned that this ruling caused great excitement in Germany and that there was a great deal of opposition. On the other hand later reports put forth the other side of the question. It is stated that the easy way in which machinery can be obtained in Germany, when being sold on the installment plan, causes the springing up of factories which have no reason for their existence, or as the report puts it, not the least right to exist. It is a common occurrence that people without a cent of capital and lacking the slightest knowledge of the trade in which they engage start a factory by obtaining the necessary machinery and plant equipment on credit. Such manufacturers are not competent to conduct the business in which they have engaged. They sell the manufactured goods at prices impossible for continuing the enterprise. Then the inevitable bankruptcy takes place and the owner of the machinery, if he is protected by a contract of sale, takes away his machinery on which he may have already received half or more of the price by installment payments. Other creditors of the firm in bankruptcy are thus so much heavier losers. This is the reason why the court has held it necessary to rule in the interest of all concerned and to thus discourage the practice of installment plan selling which at best is a poor way of selling machinery.

OBITUARY.

Willard LeGrand Bundy, inventor of the Bundy time recorder, died at his home in Syracuse, N. Y., January 19, at the age of 61. When a young man he learned the jeweler's trade in Auburn, N. Y., and in 1870 he went into the jewelry business for himself, which continued until 1889 when he removed to Binghamton, N. Y . While at Binghamton Mr. Bundy invented the first time recorder, and was one of the organizers of the Bundy Mfg. Co., of that city. In 1903 he removed to Syracuse and entered the employ of the W. H. Bundy Recording Co. Mr. Bundy was the inventor of the Columbia calculating machine, brought to a state of completion just prior to his death.

JOSHUA STEVENS.

Joshua Stevens, for many years president of the J. Stevens Arms and Tool Co., Chicopee Falls, Mass., and inventor of the Stevens single-shot pistol and rifle, died in Meriden, Conn., January 21 at the age of 92. Mr. Stevens was born in Chester, Mass., September 10, 1814, and was apprenticed in a small shop in that town in 1834. He had a most interesting experience as a mechanic, and in October, 1894, an article entitled "Sixty Years as a Mechanic" was published in MACHINERY, giving an account of his varied experiences. His early life was one of pinching poverty and long hours. He worked for $1.00 per day from 5 in the morning until 7 at night, knocking off only half an hour for breakfast and dinner. In 1837 he states in his reminiscences, flour was $11.00 per barrel, nails 7 cents per pound, and other common commodities in proportion. The modern pistol and rifle began to be evolved in 1838 and in that year Mr. Stevens went from Chester to Springfield, Mass., to work for Mr. Cyrus B. Allen, who had a small gun and pistol shop. He was afterwards associated with Mr. Harvey Waters at Stafford, Conn., and helped him turn out the first pin machine made in the United States. He later met the celebrated Col. Samuel Colt, the inventor and manufacturer of the famous Colt's revolver. Mr. Stevens is credited with having had a great deal to do with this successful development. The J. Stevens Arms and Tool Co. was started in the early 60's and in 1865 the company began the manufacture of machinists' tools, at first making a spring caliper. The tool business was discontinued in the 90's, and attention confined to the gun and pistol business, until later, with the advent of the automobile, a department was organized for this line. Although Mr. Stevens severed his connection as president of the company in 1896 he still retained an interest in its welfare and made frequent visits to Chicopee Falls, as his health permitted.

JOSEPH FLATHER.

Joseph Flather, president of Flather & Co., Inc., Nashua, N. H., died at his home, February 3, of a valvular disease of the heart, aggravated by a slight attack of pneumonia. Although in failing health for the past three or four years his death at this time was unexpected.

He was born in Bradford, England, April 1, 1837, and received his education in the common schools of that city and of Norwich, to which city his parents had moved. At the age of eleven he entered the repair shop of a large mill in Norwich and continued there for one year, when his parents again removed to Bradford. Here he was apprenticed to his uncles, William and Henry Hodgson, manufacturers of worsted machinery, and continued in their employ for about seven years. At the age of nineteen, his term of apprenticeship having expired, he, with his father took passage on a sailing vessel for Philadelphia, where they landed, after a tedious voyage of six weeks, in September, 1856.

Being unsuccessful in finding employment in or around Philadelphia they made their way to Harper's Ferry, W. Va., where relatives were located. On account of unusual ability with the file he secured work filing gun-sights at the Government Arsenal at that place. Afterwards he went to Zanesville, Ohio, to work in a railroad repair shop but soon returned to Harper's Ferry. In 1859 he went to Nashua, N. H., and entered the employ of Chase & Co., manufacturers of sewing machines. He continued there until the Civil war broke out

Joseph Flather.

when he secured contract work in gun factories in Binghamton, N. Y., Yonkers, N. Y., Trenton, N. J., and Bridgeport, Conn.; while at the latter place he worked on the tools used for the manufacture of the Henry repeating rifle, the first of its kind used by the Union troops.

At the close of the war Mr. Flather, with two brothers, moved to Parkersburg, W. Va., and established a shop for the manufacture and repairing of oilwell tools, but the venture was a failure owing to the habit of the oilwell proprietors combining business with pleasure; instead of trading near home, they would take a holiday and spend their money in Pittsburg and other cities. Returning to Nashua once more, in 1867, he, with his brothers, Edward and William J., formed a partnership with the late J. K. Priest, who at that time manufactured sewing machines but who later established himself, under the title of the American Shearer Co., as a manufacturer of clippers of all kinds. It was the idea of the Flather brothers and Mr. Priest to manufacture not only sewing machines but lathes, but the lines were so dissimilar that the partnership was soon dissolved, the Flather brothers taking over the lathe department. It was at this time that the firm of Flather & Co. came into existence, Joseph and William J. being the active partners and Edward the silent one. Times were very dull and business scarce, and the success of the firm hung in the balance for many years. After several changes in location and with varying success the firm built a wooden shop on the site of their present building. This building was destroyed by fire September 29, 1876. Everything was destroyed and the loss was total, excepting two or three thousand dollars insurance. With this money the shop was rebuilt on the same location but this time with brick, the wisdom of this being shown in the fact that this building is still a section of the present works. In 1876 the concern exhibited their lathes at the Centennial Exhibition held in Philadelphia, and it was here they secured their first foreign business, their lathes having attracted the attention of manufacturers from Eskilstuna, Sweden, and Frankfort, Germany. This small beginning paved the way to what has proved to be a large and profitable foreign trade, extending further and further until now it includes every country where machine tools are used. During all the "panic" years up to 1879 the firm had great difficulty in making both ends meet and only succeeded by the greatest economy and perseverance and the willingness to do anything, including job work, special machinery and even making two-wheeled velocipedes, the forerunner of the later safety bicycle. After the panic years matters took on a brighter look and early in the 80's the firm was established on a sound basis and began to enlarge. With continued prosperity more additions were made until the present size was obtained, beyond which Mr. Joseph Flather had no ambition to go, although several times business conditions would justify further increase. In 1885 Mr. Flather invented the "patent feed" so called, which was the first successful effort

in placing the rod and screw on the front of the lathe so that either could be driven by both belt and gears. He also invented many other improvements of consequence. In 1901, the partnership existing between the brothers, having expired, Mr. W. J. Flather withdrew and the company was incorporated under the title of Flather & Co., Inc., with Mr. Joseph Flather as president and treasurer, which office he held at the time of his death.

Mr. Flather was widely known, in his adopted city and among the manufacturers of machinery. He took pride and comfort in his family, making them his confidants in all personal and business affairs, and it was with them that he consulted rather than with friends. He was especially fond of reading, and had traveled extensively both in this country and Europe. He served his ward in both branches of the city government; he also served a term as representative to the General Court (State Legislature). For ten years he was a member of the board of education, the last two of which he acted as its president. When the National Machine Tool Builders' Association was formed in 1901 he was honored by being selected as its first president, which office he held for two years. He is survived by his wife and seven children, among whom are Mr. F. A. Flather, treasurer Boott Mills, Lowell, Mass., and H. L. Flather, superintendent Flather & Co., Inc.

HENRY CLARK SERGEANT.

Henry Clark Sergeant, of the Ingersoll-Sergeant Drill Company—now an integral part of the Ingersoll-Rand Company—died at his home, Westfield, N. J., January 30, seventy-two years old.

Mr. Sergeant was of world-wide repute as a prolific and highly successful inventor, especially in the line of rock drills, air compressors and mining and excavating machinery in general, his active life having been coincident with the period of development of the modern and phenomenally efficient apparatus now so universally employed and with such industrially revolutionary results, he having been a leading and constantly active agent not only in the line of invention and improvement but also in the devising of the details and the means of precise and economical manufacture.

Mr. Sergeant was born at Rochester, N. Y., but his earlier years were spent in Ohio. He was of uncurbable activity, both physically and mentally, from the beginning. He had only a common school education and was working in the machine shop at a very early age. His inventive faculty made work for itself from the first. He quickly began to see the undeveloped possibilities of systematic manufacture by the aid of special machinery. His first practical application of his theories was to the making of the spokes, hubs and felloes of wagon wheels. He designed special machines for this work and at the age of eighteen he accepted a contract for manufacturing wheel parts in quantity. In this he was so successful that in two years he was taken into partnership by a firm manufacturing wagon wheels.

The routine of the factory, however, could not hold him, and after severing this first business connection, the next six years of his life were spent in various pursuits, chiefly commercial, in which he met with varying success. He was a ready speaker, though not known as such in later years, and found favor as a lecturer. He had figured for a time also as a champion skater. He still found time and opportunity in the line of invention and the development of labor saving machinery. His first United States patent, issued when he was nineteen, was for a boiler feed. Succeeding patents suggest the range of applicability of his inventive faculty. In December, 1858, he patented a steam engine governor. This was in fact a governor for marine engines to prevent their racing to destruction when the wheels were out of water. This was soon after adopted by the U. S. government and applied to the warships of the period. He had after that patents respectively for gas regulators, for steam pumps, four for steam boilers, five for brick machines, a fluting machine, six for water meters, all these before he had struck what must now be considered his life work.

Three of the brick machine patents were issued in 1867 when he was a resident of Columbus, Ohio, but soon after that

Henry Clark Sergeant.

he started a machine shop of his own in New York, building a wide variety of machines and developing many crude ideas into practical working successes. In the early seventies hither came Simon Ingersoll with the drawings for the first Ingersoll rock drill, a then untried device. The possibilities and the large future for the rock drill particularly attracted Sergeant. None can say now how much he contributed to the development and success of the original Ingersoll drill, but at least one patent was issued to Ingersoll and Sergeant as joint inventors. The Ingersoll Drill Company was formed and introduced the drill in the rock excavating fields.

Although the drill was at first operated only by steam, its advantages when driven by compressed air and the absolute necessity of using air for mine and tunnel work turned Sergeant's attention to the improving of the design and details of the air compressor, which the Ingersoll Company began to market in connection with the drills and for other incidental uses which began to develop. He was soon working with all his energies in both lines and constantly bringing both the drill and the compressor into higher efficiencies. As the business grew the partnership of Sergeant & Cullingworth was formed with shops at 22d Street and Second Avenue, New York.

The water meter patents spoken of were issued during these early business years in New York, and in this line he was in touch with José F. De Navarro, two patents issuing to the latter as joint inventor with Sergeant.

Again turning from the task of manufacturing, Mr. Sergeant's interest was sold to the Ingersoll Drill Co., and he went to Colorado to put into practical operation some of his mining methods. He operated a silver mine for a time, but, fortunately we may now say, it was not a success. Meanwhile he had developed another complete rock drill with an entirely novel valve motion. Two patents on this drill are dated 1884. He brought his new drill East in 1886 and formed the Sergeant Drill Company, which began building the drill at Bridgeport, Conn. Two years later the new company joined hands with the Ingersoll interests and the Ingersoll-Sergeant Drill Company was formed with Mr. Sergeant as its first president. The new company's shops were at 9th Avenue and 27th Street, these shops having been occupied for a short time previously by the firm of Sergeant & Cullingworth which then went out of existence, Mr. Sergeant's interest in this firm having terminated before he went to Colorado. Mr. Sergeant remained at the head of the company but a short time, he then disposing of the bulk of his interest. A considerable time was then spent in London and Paris. He returned to the rock drill business, this time as a director in the Ingersoll-Sergeant Company, with the purpose of devoting all his time to invention in the interest of the company. He labored constantly in developing and improving the company's products and in spreading their application into new and wider fields, his most notable inventions being the Sergeant "auxiliary" and "arc" valves, "tappet" rock drills, the Sergeant "release rotation"

for rock drills and the "piston inlet" valve for air compressors, all of which are in general and successful use to-day. He was also the originator of many new ideas in stone channeling, coal undercutting and associated lines.

In the days of the Sergeant & Cullingworth Company, in response to the solicitations of the management of the Third Avenue Elevated Railroad Company, of which he was then a director, for a device which would protect them from the constant losses accruing from the repeated use of uncancelled tickets, he designed the ticket cancelling box now so familiar to the public, which so mutilates the ticket as to make it impossible to defraud the company by using it again.

Mr. Sergeant's inventive faculty and his suggestive and stimulating ideas were devoted to the interests of the Ingersoll-Sergeant Company for all the remaining years of his active life, and the business grew and prospered continually. The works at Easton, Pa., were occupied in 1873; the great shops at Phillipsburg proved a necessity a decade later; the consolidation of the two foremost but competing companies in their line in the world into the Ingersoll-Rand Company was the latest and final success. He spend much of his time in Easton until two years ago when failing health compelled him to give up his former activities. After the consolidation of the Ingersoll-Sergeant and Rand Companies he still retained his interest, although his health would not permit his active participation.

In his early days Mr. Sergeant was never content to tarry long under fixed conditions or in the same location, and up to 1893 he had made his home in twenty-six different cities and towns. In that year he located at Westfield, N. J., and at once took a deep interest in the growth of what was then but a small settlement. He built and owned at the time of his death the present home of the Westfield Club, the leading social organization in that section. He suffered greatly from rheumatism in his latter years, but the immediate cause of his death was paralysis.

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PERSONAL.

Thomas Farmer, of Detroit, Mich., has accepted a position with the Warner & Swasey Co., Cleveland, Ohio, as their Western representative.

J. C. Linder, for many years connected with the Abrasive Material Co. of Philadelphia, Pa., has been appointed superintendent of the vitrified wheel department of the Star Corundum Wheel Co., Detroit, Mich.

H. F. J. Porter has opened an office at 1 Madison Avenue, New York, and will engage in consulting industrial engineering work, making a specialty of organizing manufacturing companies on the basis of "industrial betterment."

William Coghlin, for nine years past prominently identified with The National Supply Company of Toledo, Ohio, has severed his connection with that company and entered the employ of The Patterson Tool and Supply Company of Dayton, Ohio. He expects to travel for the company in Ohio.

M. Woolsey Campau has accepted the position with the C. C. Wormer Co., Detroit, Mich., to represent that company on the road, principally in Michigan as salesman for steam plant machinery and machine tools. Mr. Campau is a graduate of the University of Michigan, 1897, engineering course.

Robert S. Riley, of New York, has taken over the control of the American Ship Windlass Company, Providence, R. I. Under the new management the company is making improvements in manufacturing facilities and preparing for an expansion of business. Mr. Riley was formerly with the New York Shipbuilding Company, and is also a director and consulting engineer for the Enterprise Transportation Company.

Fred. J. Miller, editor-in-chief of the *American Machinist*, resigned his position January 26. Mr. Miller was with the paper nearly twenty years—eight years as associate editor and twelve years as editor. At the present time poor health has prevented any definite plans for the future; it is not probable, however, that he will entirely give up the writing on mechanical subjects and kindred topics that has been his chief occupation for so many years, and which has made him so well known throughout the engineering world.

RECENT MILL HEATING INSTALLATION.

The new mill of the Blackstone Manufacturing Company, of North Smithfield, R. I., contains 40,000 spindles, and is a structure of three stories and basement, 366 feet long by 130 feet wide. On the east end is a picker house, 100 x 67 feet in plan, two stories and basement high, the latter being used as a dust room. At the west end is a weave shed 89 x 130 feet in plan, composed of one story and a full story basement. Both wings are built to carry additional stories in the future to the full height of the mill if desired, and the total frontage of the mill as now existing is 522 feet with a depth of 130 feet for most of this distance. The mill building is heated on the indirect system, consisting of steel plate fans and heaters installed by the B. F. Sturtevant Co., Boston, Mass. The heating coils and fans are located near the center of the west basement wall and the warm air is delivered to a number of vertical brick distributing flues by a horizontal concrete duct running beneath the basement floor along the entire course of this wall. The heating coils are located practically at the center of the duct which has a cross-sectional area of 8,640 square inches opposite the coils. The coils consist of a bank of about 12,000 feet of 1-inch pipe and the air is forced through the system by two 10½-foot fans, each direct-connected to a 10 x 12-inch engine. The typical vertical distributing flue starts from the basement with a 40 x 26-inch section, decreasing to a 20 x 26-inch section on the third floor. The openings from these for the supply of each floor are 20 inches square in sectional area, with the exception of the third-story opening, which has 20 x 24-inch dampers. The bottoms of the damper openings are located 10 feet above the floor level. Thence the air is forced across the entire width of the building, a distanc of 130 feet, and is thoroughly distributed. Perfectly equable temperature is thereby maintained. The slight excess of air pressure within the building tends to outward leakage.

* * *

The spring convention of the National Machine Tool Builders' Association will be held at Fortress Monroe, May 7 and 8, with the Hotel Chamberlin as headquarters. It is expected that there will be a large attendance on account of the popularity of the place and the fact that the time is shortly after the opening of the Jamestown Exhibition. Further information may be obtained from the secretary, Mr. P. E. Montanus, of the Springfield Machine Tool Co., Springfield, Ohio.

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FRESH FROM THE PRESS.

We neglected to state in the review of the work "Electrical Engineering," by E. Rosenberg, reviewed in the February issue of Machinery, that the publishers are John Wiley & Sons, New York.

E. J. Frost, Jackson, Mich., has reduced the price of his book, "Essential Data on Bevel Gearing," to $3.00. This work, which was reviewed in Machinery, November, 1905, gives the face angle, cutting angle, outside diameter, pitch, cone radius, and number of Brown & Sharpe standard cutter for bevel pinions of 9 to 70 teeth inclusive, mating with tooth numbers 9 to 132 inclusive, all of 1 pitch; the lineal dimensions of other pitches are readily deduced by simply multiplying or dividing by the given factor. It contains in all about 70,000 items of computed data, the object of which is to do away with mathematical drudgery in the drafting room and shop.

Modern American Machine Tools. By Prof. C. H. Benjamin. 320 pages 5½ x 9, 134 illustrations. Published by E. P. Dutton & Co., New York.

This work on American machine tools, reviewing their general characteristics, is the same as that noted in the January, 1907, issue which was brought out by Archibald Constable & Co., London. The American rights have been acquired by the above concern.

Artillery and Explosives. By Andrew Noble. 548 pages, 6 x 9½ inches. Published by E. P. Dutton & Co., New York. Price $6.00.

This book contains a number of essays and lectures written and delivered at various times. While for this reason not a complete and logically arranged work, it contains a mass of valuable information to persons engaged in the design and testing of large guns, and particularly to those interested in the qualities of explosives. A great deal of attention is given to researches and experiments on explosives, and to the peculiarities of their action in rifled artillery.

The Schulz Steam Turbine for Land and Marine Purposes. By Max Dietrich. 73 pages, 6 x 9¼ inches. 43 cuts. Published by E. P. Dutton & Co., New York.

This is the first volume of a series of treatises entitled Modern Steam Turbines, edited by Arthur R. Liddell. It is merely a review and description of the Schulz patents and a summary of the experiments and tests undertaken with the Schulz steam turbine. The volume may be of value to those who wish to closely follow up what improvements are made in steam turbine design.

The Elastic Arch. By Burton R. Leffler. 59 pages, 5 x 7½ inches. 3 folding plates. Published by Henry Holt & Co., New York. Price $1.00.

This work is a treatment of the theory of the elastic arch, with special reference to the reinforced concrete arch. It gives a method of designing a reinforced concrete section for combined thrust and moment; it also includes a graphical analysis of an arch of oblique forces. The arch is analysed and theoretic deductions given. The work is timely in its treatment of reinforced concrete and its vagaries.

CONTENTS FOR MARCH.

"New York Central Lines" is an interesting illustrated pamphlet of 8 pages, concisely and carefully written, which describes the new motive power on the Hudson and Harlem Divisions of the New York Central. The adoption, by the New York Central, of electricity as the motive power for its enormous passenger traffic into and out of its terminus at Grand Central Station, New York, marks a new era in passenger transportation in America. A few days ago there were eighty-four trains being operated in and out of Grand Central Station either by electric locomotives or multiple unit controlled electric cars. A copy of the above pamphlet will be sent free to any address in the world on receipt of a two-cent stamp by George H. Daniels, Manager, General Advertising Department, Grand Central Station, New York.

It is like the song of the robin after the long winter silence, to take up the March *Century* and find so many pages given over to gardens and growing things. We are glad to get out of doors again after the snow, and there are so many gardens it's hard to choose which we like best. Miss Frances Duncan writes charmingly of "Charleston's Gardens," and her story is enhanced by two full page illustrations in colors and numerous half tones. "Persian Gardens" are brought to our notice both in words and sketches by Bertram Grosvenor Goodhue; and William H. Tolman has written much that will make us thoughtful in his account of the "Workingmen's Gardens in France." Miss Zaida Ben-Yusuf's paper on "The Honorable Flowers of Japan" introduces us to Japanese methods for arranging cut flowers, and the review of "Luther Burbank's Ideas of Scientific Horticulture" brings a new, suggestive and authoritative presentation of Mr. Burbank's claims and achievements.

The Principles of Mechanism. By Herbert A. Garratt. 166 pages, 5 x 7¼ inches. 162 cuts. Published by Edward Arnold, London, and Longmans, Green & Co., New York.

This small volume, which purports to be a short treatise on kinematics and dynamics of machines, deals with its subject in a purely theoretical manner. It will undoubtedly be serviceable to everybody who wants to study the principles of kinematics without spending too much time and energy on a voluminous presentation of the matter. The various subjects dealt with are treated in as simple and comprehensive a manner as is consistent with the object of the book.

The Slide Rule: A Practical Manual. By Chas. N. Pickworth. 104 pages, 5 x 7 inches. 24 illustrations. Published by D. Van Nostrand Co., 23 Murray St. and 27 Warren St., New York. Price, $1.00 net.

This little book has now reached a tenth edition, a fact which gives reasonably sure evidence of the usefulness of the work. Considerable additional matter has been incorporated, especially that relating to new forms of "log.-log." slide rules, and other special instruments of recent introduction. The book takes up, in turn, the mechanical and mathematical principles of the slide rule, the explanation of the simpler uses of the ordinary forms proceeding from that to compound multiplication and division, involution and evolution, trigonometrical applications, etc. A valuable table of conversion factors is given, as well as settings for constants used in various branches of engineering. A large number of practical examples are worked out.

Steam Turbines. By Lester G. French. 418 pages 6 x 9 inches, 250 cuts. Published by the Technical Press, Brattleboro, Vermont. Price $3.00.

This work had its inception in the editorial offices of Machinery, when the author was its editor, and a number of the chapters, in whole or in part, were published in its columns during 1904, 1905 and 1906. Hence the general character of the work is already known to many of our readers. The work explains the principles of the steam turbine, gives a brief resume of the history of the art, and then follows with detailed information about the various types of steam turbines that have been built. These chapters include simple impulse turbines, the Pelton and similar types, compound impulse turbines, reaction turbines, and miscellaneous types. A valuable chapter on steam turbine performance follows, containing tables of results of turbine tests and of tests upon reciprocating engines, for convenience in comparison. The continuation of this chapter takes up the characteristics of turbines for variable loads, the effect of vacuum on economy effect of superheating, etc. Chapter XI is devoted to experiments on the flow of steam and represents a great deal of labor and research on the part of the author and others. The appendix includes four diagrams showing the kinetic energy of steam in foot-pounds and the velocity of a steam jet in feet per second. The mathematical treatment has been limited mainly to a discussion of the adiabatic flow of steam and to the principles of turbine vanes, etc., and has been made as simple as the nature of the subject will permit. In this connection it might be noted that Mr. French's editorial work on Machinery for the past nine years well fitted him for the preparation of such work, which is designed to appeal to all classes of men interested in prime movers, whether firemen, engineers, inventors or designers. It is presented in simple language and the underlying principles and application are intelligently discussed in a manner that makes a study of the work a pleasure. The typographical appearance of the work is exceptionally fine. It is well printed and well bound. The engravings, both line and half-tone, are exceptionally good, and altogether the work is one that can be referred to as a standard of what a technical work should be.

Engineering Materials. By Edward C. R. Marks. 98 pages, 4¾ x 7½ inches. 38 cuts. Published by the Technical Publishing Co., Ltd., Deansgate, Manchester, and Strand, London. Price, 60 cents.

The book in review is of the second edition and has been entirely rewritten and added to, making largely a new work. It is the aim of the work not to present an exhaustive treatise of metallurgy, but to give concisely practical information on the characteristics of the principal engineering metal materials, therefore treating of cast iron, wrought iron, steel, copper, brass, malleable iron, babbitt or bearing metals, etc. The aim of such a work as this is to be commended. There are many who desire elementary books on almost any given subject which will give a general grasp of the subject as a whole without going into minute details. In fact it is in general necessary for any one in approaching a subject to be able to comprehend the principal facts of the subject before they are in proper condition to study its details. The work in review is one which might be unfavorably criticized in some respects, and commended in others. In places it seems to lack authority of expression, but substitutes quotations from papers by eminent metallurgists. In a book of this character we believe there should in general be the assumption of authority on the part of the author to make certain definite statements. It will satisfy most readers of the elementary class far better. Some parts are well done; the chapter on steel explains the difference between the acid and basic process steels which are made by both the open hearth and Bessemer methods. It is pointed out that high-grade crucible steels are by necessity high-priced, inasmuch as they must be made from iron free from sulphur. This in England largely means Dennemora or Swedish iron. These irons cost from 5 to 6 cents per pound to begin with, hence the impossibility of producing first-class crucible steel at the prices often quoted. The cheap processes for manufacturing crucible steel have one and all failed, and to-day the old-time method pursued by the Sheffield steel makers is still the one that produces the reliable tool steels.

NEW TRADE LITERATURE.

Kerr Turbine Company, Wellsville, N. Y. Bulletin No. 2 describing the Kerr steam turbine and steam turbine blower sets.

New Haven Manufacturing Co., New Haven, Conn. Crystaloid sign advertising 36-inch swing engine lathe.

Goldschmidt-Thermit Co., 43 Exchange Place, New York City. Pamphlet on Thermit Rail Joint describing welding outfit, material and working plan.

B. F. Barnes Co., Rockford, Ill. Illustrated catalogue of "Twentieth Century" machine tools describing upright drills, lathes, tool grinders, key seaters, etc.

American Blower Co., Detroit, Mich. Catalogue No. 206 on vertical self-oiling engines, stating points of superiority, adaptability, economy, describing lubricating system and giving tables of specifications.

Garvin Machine Co., Spring and Varick Sts., New York City. Circulars Nos. 53 and 54 illustrating and describing vertical spindle milling machines and motor driven milling machines respectively.

Gisholt Machine Co., 1316 Washington Ave., Madison, Wis. Leaflet describing a pulley job which shows how this class of work can be finished to good advantage on the American turret lathe.

Niles-Bement-Pond Co., Trinity Building, 111 Broadway, New York City, have issued *Progress Reporter* for March, 1907, which treats of Pratt & Whitney 16-inch toolmakers' lathe, pneumatic clutches for planer drives, 600-ton hydraulic wheel press, etc.

The R. A. Kelly Co., Xenia, Ohio. New catalogue describing their entire line of crank shapers. All of these shapers may be readily equipped for electrical driving. Prices for extra attachments will be furnished upon request.

Baker Brothers, Toledo, O. Catalogue No. 5B describing drilling, boring and tapping machinery, among which are included manufacturing drills for general machine shop use, semi-automatic tapping machine, car wheel boring machines and locomotive rod boring machines.

Cleveland Twist Drill Co., Cleveland, O. Catalogue 32 illustrating and giving specifications for their line of drills, reamers, sockets, bits, taps, etc. A number of new tools are included. Catalogue 34 devoted to high-speed drills, containing hints on the use of high-speed drills as well as specifications for the various types.

The International Committee of Young Men's Christian Associations, 3 West Twenty-ninth St., New York, have issued *Progress and Outlook*, for 1906, summarizing the year's work. Special attention is called to the page containing the summary of a year's growth and to the page concerning the association's railroad buildings.

The Ingersoll-Rand Co., 11 Broadway, New York. Catalogue H-36. Describing a single line of air compressors known as type H. These air compressors are duplex, steam-driven, automatic machines mounted on a single base and entirely self-contained, and are made in sizes ranging from below 10 to over 200 horse-power.

The B. P. Fortin Tool Co., Woonsocket, R. I. Catalogue describing and giving specifications of the B. P. Fortin universal jigs. It is the

RAILWAY MACHINERY.

A special edition of MACHINERY devoted to Locomotive and Car Equipment and Mechanics.

April, 1907.

ELECTRIC LOCOMOTIVE FOR ILLINOIS TRACTION SYNDICATE.

THE accompanying cut, Fig. 1, shows one of two locomotives recently built by the General Electric Company and the American Locomotive Company for the Illinois Traction Syndicate.

The locomotive is a swivel truck switching type weighing 40 tons on drivers, and equipped with 4-GE-55-H motors; in other words, is classified as a 404-E-80-4-GE-55-H type, in accordance with the standard system of classification recently adopted by these companies for rating of electric locomotives.

The cab is the well-known switching locomotive cab of the general type developed some years ago by the General Electric Company, having a main operating cab, and sloping end cabs; the operating cab has a floor space of 8 feet x 9 feet 6 inches, and stands in the center of the locomotive; it contains an air compressor, together with engineer's seats at the operating windows, control mechanism, master controllers, brake valves and sander apparatus.

The end cabs are of the most recent type, covering a floor space of 9 feet 6 inches x 5 feet 6 inches each and leaving a 24-inch side platform on either side running from the operating cab to the end of the locomotive. The doors from the operating cab open at diagonally opposite corners on this side platform, thereby giving easy access from the locomotive cab to the end of the locomotive for coupling purposes, while on the operating side it gives the engineer an unobstructed view of the track in front of him, or of the train which he may be handling to the rear, and of the brakeman or switchman at the couplers.

The cab framing is built of 2 x 2-inch and 3 x 3-inch angles, with sides and roof of No. 8, or ⅛-inch sheet steel. The end cabs are bolted to the floor and main cabs through gaskets, or shielding angles, to protect against rain wash.

The platform is built up of a framing consisting of four 10-inch channels running the length of the locomotive and riveted to the end frames and bolster. The end frames are iron castings with push pole sockets cast near the outer ends, and with lugs for riveting to center and side sills and the draw bar castings. Over the center pins the sills are trussed together with heavy braces stiffened by castings and forming a built-up body bolster. The floor consists of solid sheets of ⅜-inch plate, riveted to the longitudinal sills and serving as a stiffening member for the frames. The M. C. B. vertical plane coupler is carried in a draw bar casting bolted to the end frame and center sills.

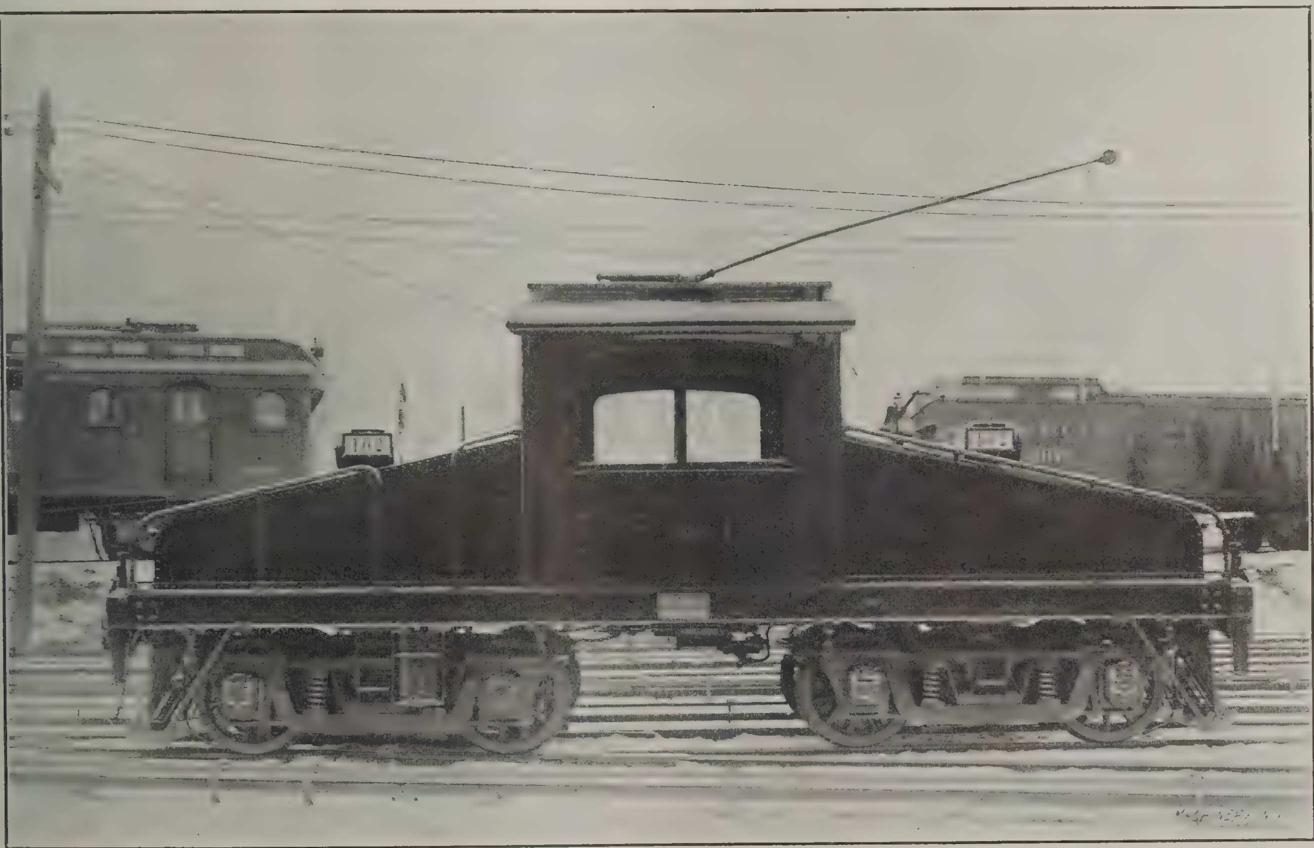


Fig. 1. Electric Locomotive built by the General Electric Co. for the Illinois Traction Syndicate.

On each end of the platform is carried a heavy pilot built of 1-inch round bars riveted to a ½-inch bottom plate below and the 4 x 4-inch angle above. This angle in turn is bolted to the end frame of the locomotive with space blocks which permit adjustment in height of the pilot, and the whole is braced with two center braces and two side braces extending from the pilot bottom brace to the center and side sills of the platform. The pilot steps on the pilot and stirrups on the end frames give easy access to the side platforms of the locomotive at each end.

The truck is of the M. C. B. equalized type with plate bolster. The wheel-base is 6 feet 6 inches; the wheels are 36 inches diameter with fused steel tires and the journals are 5½ x 10 inches, the construction being particularly heavy in order to meet the demands of locomotive service. The weight of the truck is carried upon equalizers, each of which is made of two 5½ x 1½-inch bars held apart by suitable distance pieces and carrying the truck frame on spiral springs. The top frame is a 2 x 3½-inch rolled bar, and end frames of the same section are bolted to it. The truck transoms are

built up of 13-inch channels riveted to ½ x 18-inch gusset plates and securely bolted to the truck frame. The plate bolster carrying the center pin and side bearings is built up of 9-inch channels and plates riveted together. The whole truck construction, as remarked above, is peculiarly heavy and is designed particularly for the type of service to which it will be subjected.

The motor equipment is of the builder's railway type. This type was designed especially for the slow speeds and heavy tractive effort required in locomotive service. At the rated load of the motors the locomotive will give a tractive effort at the rail of 16,800 pounds, and at the slipping point of the wheels will develop 20,000 pounds tractive effort with a load on the motors slightly in excess of their rated load.

Fig. 2 is a view of the interior of the locomotive cab showing the apparatus at one of the engineer's operating positions, and a view of the interior of the end cab. In front of the engineer's seat stands a master controller operating the contactors used for type M single unit control. Brake apparatus for both straight and automatic air, and pneumatic sanding valves are also within easy reach. In the end cab are contained the contactors and rheostats of the control system. The air reservoir and pneumatic sanders arrange for sifting sand through nozzles carried upon the trucks directly in front of the forward wheels of the locomotive. In the center of the main operating cab stands a CP-23 air compressor operated from the 500-volt circuit, having a piston displacement of 50 cubic feet per minute.

Some of the particular dimensions of the locomotive are:

Length over all	31 feet 1 inch
Height over cab	11 feet 9 inches
Width over all	9 feet 6 inches
Rigid wheel base	6 feet 6 inches
Weight of electrical equipment	27,500 pounds
Weight without electrical equipment	52,500 pounds

* * *

It is said that the present King Edward of England draws more revenue in interest on American securities held by his royal household than George III. ever exacted from the American colonies.

ELECTRIC RAILWAY MACHINERY AND APPARATUS.—2.

WILLIAM BAXTER, JR.

The magnetic envelope that surrounds an electric current is the means or agency through which the energy of the current is converted into mechanical energy in electric motors, and the energy of a steam engine is converted into electric current in a generator; therefore, the properties of this envelope should be thoroughly understood. For this reason we will discuss the subject at some length in what follows.

Properties of the Magnetic Envelope.

In Fig. 2 we have shown that when a magnetized needle is placed parallel with a wire running north and south, it will be swung around to the east or west if a current flows through the wire, the direction of swing depending upon the direction of the current. This, however, is not the only direction in which a needle will be swung when placed near a wire carrying an electric current. In Fig. 3 let *A* represent the end of a wire suspended in a vertical position, the observer being stationed above and looking down upon it. Let the arrows *B* represent a number of small magnetized needles held so that they may swing freely in a horizontal plane around their center point. If an electric current is passed through the wire, from the top downward, all the needles will swing into tangential positions as shown in the illustration, with their north ends pointing to the right, as seen from the direction of the wire. If the direction of the current through the wire is now reversed, so that it runs up toward the observer, the needles will at once swing around through a half revolution so as to point in the opposite direction from that in which they are drawn, but they will again arrange themselves in positions tangent to the circle they form. This tangential position will be taken provided the current through the wire is very strong and the needles are close to the wire. If the current is weak, or the needles are some distance away, they will not assume a truly tangential position, but will tend to reach such a position. If the current through the wire is discontinued, all the needles will at once swing around

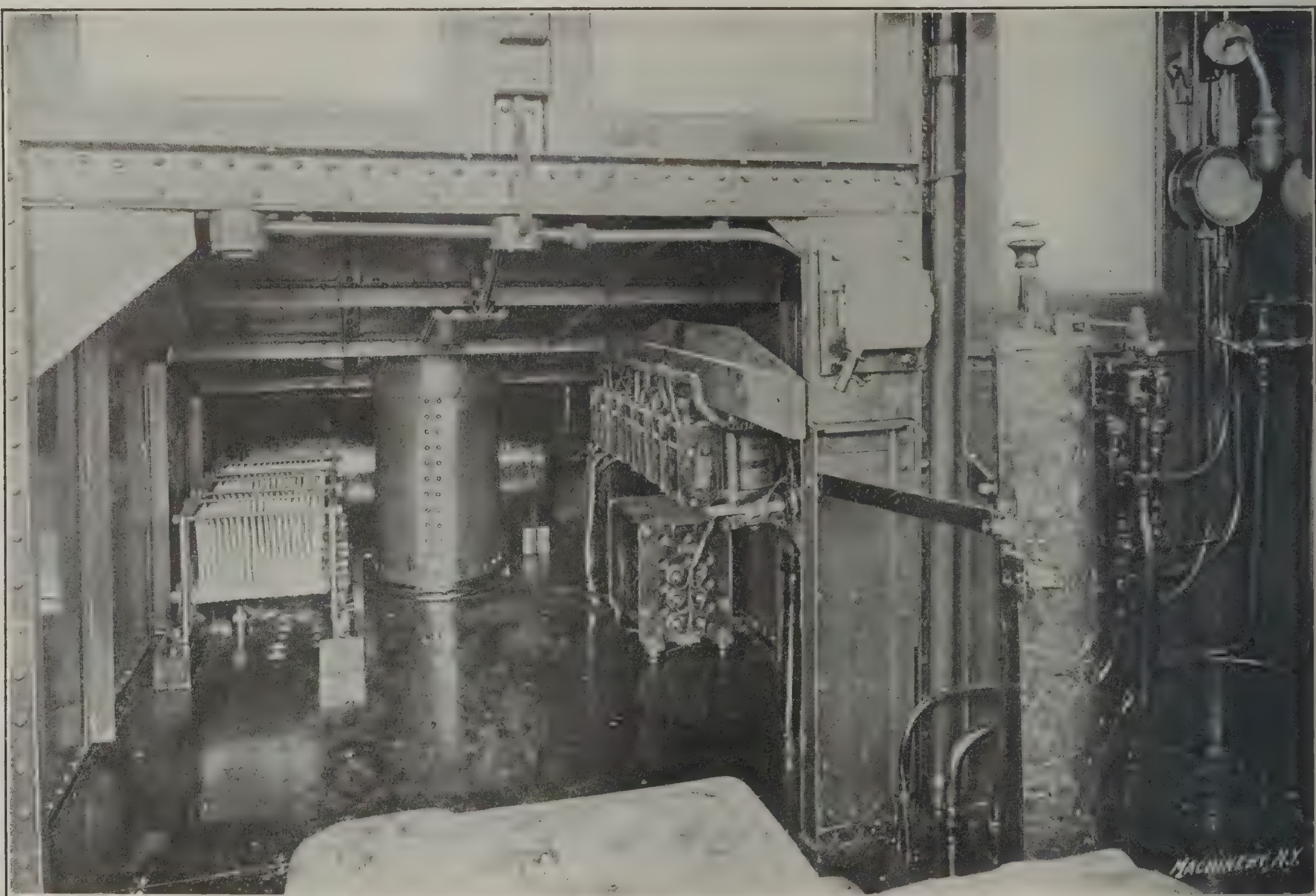


Fig. 2. Interior View of End Cab and Engineer's Cab, showing Master Controller, Etc.

into positions parallel with one another, and pointing to the north. From this experiment we see that the current flowing through the wire exerts a force to swing the needles away from north and south position, against the attraction of the earth's magnetism, into a position tangent to the circle struck from the wire as a center. If we provide ourselves with means for varying the strength of the current passing through the wire, and begin by passing a very weak current and increase the strength gradually until it becomes very strong, we will note that at first the needles will swing but slightly from the north and south position, but will gradually swing further toward the tangential position as the current strength is increased. This last experiment shows us that the force exerted by the current to swing the needles around into the tangential position, increases as the current increases.

If the needles B are suspended from short silk threads, so that they may move freely in any direction, as well as swing about their centers, we will find that if we again pass the current through the wire, increasing its strength gradually, the needles will not only swing around on their centers, but will actually move bodily toward the wire; and if the current strength continues to increase, the needles will move toward the wire until their ends come in contact with each other, thus forming a complete closed ring of needles. If the current is still further increased, the needles will act as if they were pushing against each other, and at some points of the ring they will be pushed out, and will double up on one another, while at other points they will push in toward the wire, until the whole bunch of them becomes crowded tightly against the sides of the wire.

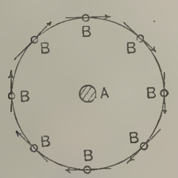


Fig. 3

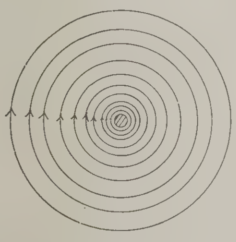


Fig. 4

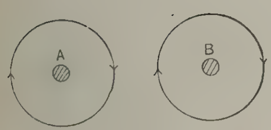


Fig. 5

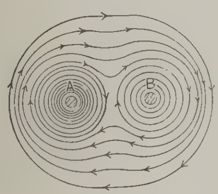


Fig. 6

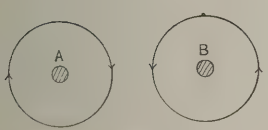


Fig. 7

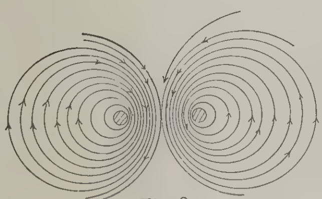


Fig. 8

Machinery, N.Y.

Illustrating Action of Lines of Magnetic Force.

The experiments explained in connection with Fig. 3 demonstrate the fact that the magnetic envelope that surrounds an electric current exerts a force that not only acts at right angles to the axis of the wire carrying the current, but also in a direction tangent to a circle drawn from the wire as a center. This force is of a pulling or tractive nature, as is shown by the fact that the needles are drawn into a smaller circle when free to move. It might be supposed that this attraction is explained by the fact that the needles are magnets and, therefore, pull on one another, but this is not the case, because the same result can be obtained by substituting pieces of soft iron wire for the needles. With a weak current passing through the wire, the needles would be drawn toward the wire with more force than the pieces of iron wire, but with a sufficiently strong current the pull with the iron wires would be the greater. For the purpose of being able to easily explain or represent the action of the magnetic envelope of an electric current, it is customary to draw lines in the direction in which the magnetic force acts. These lines are called magnetic lines of force. The space surrounding a current in which the action of the magnetic force is strong enough to be noticeable, is called the magnetic field. The field is commonly represented on paper by drawing a large number of lines of force, as is shown by the circles in Fig. 4, the shaded center representing the wire. The magnitude of the magnetic force in the field surrounding a wire is greater at the surface of the wire than at any more distant point, and gradually reduces as the distance from the wire increases. Within a distance of a few feet from the wire, the strength of the field decreases rapidly, but beyond that the decrease is more gradual, and theoretically the outermost boundaries of the magnetic field are only limited by the dimensions of the universe itself. Practically, however, the space surrounding a current that is considered the magnetic field of that current is only that portion in which the effects produced are sufficient to be noticeable in the service to which the current is applied. Thus the field of a wire carrying a current in an electric machine may have a radius anywhere from a few feet down to a few inches, but very much weaker currents may be regarded as having far more extensive fields when used for work requiring exceedingly feeble forces. The field of a wire carrying a current of ten amperes cannot be detected at a distance of a foot by instruments used for rough heavy work, but a field of the one-thousandth part of this strength can be detected at a distance of several hundred feet with the proper kind of instruments. To indicate the fact that the magnetic field surrounding a current is stronger near the wire than at points some distance away, it is customary to draw the circular lines of force closer together near the wire, gradually increasing the distance between them as they spread out, in the manner shown in Fig. 4. Arrow heads placed on these lines also indicate the direction in which the force acts.

Lines of Magnetic Force Likened to Rubber Bands.

In Fig. 5 let the two circles A B represent wires in which electric currents are flowing, both in the same direction; that is, away from the observer. According to what has been said in connection with Figs. 3 and 4 it will be understood that the arrow heads on the circles surrounding these wires indicate the direction of the pull in their respective fields. In the space between the wires it can be seen that the two magnetic envelopes act in opposition to each other. Now the two magnetic fields cannot occupy the same space when acting in opposition, as one would simply neutralize the other. Owing to this conflicting state of things, only a portion of the field of each wire will pass through the space between them, the outer portions will join hands, so to speak, and envelope the two wires in the manner clearly shown in Fig. 6. If the two wires are suspended so as to move freely toward each other, they will not remain separated, as in the illustration, but will at once draw together. This action shows clearly that the magnetic lines of force act as if they were rubber bands and shrink up so as to pull the wires together. On this account many writers are in the habit of comparing lines of force to rubber bands having the power of contracting and expanding indefinitely.

If the two wires of Fig. 5 are traversed by currents flowing in opposite directions, then the direction of the pull of their magnetic fields will be as indicated in Fig. 7 by the arrow heads on the circles surrounding the wires A B. Looking at this diagram it will be seen that the two magnetic fields pull in the same direction in the space between the wires, hence, they will not oppose the presence of each other in this space, but as both will crowd the space the effect will be to force the lines of force out of the position concentric with their respective wires, and make them assume eccentric positions, as is shown in Fig. 8. If in this case the two wires are suspended so that they can move freely away from each other they will at once spread apart. This action shows that the tendency of the lines of force is to remain central with the wire whose magnetic envelope they represent, and that a force must be applied to shift them out of this position.

In view of the fact that in Fig. 6 the lines of force of the two wires link together and pass around both wires as a single magnetic envelope, it will be inferred at once that if we had three wires with currents flowing through them in the same direction their lines of force would link into one magnetic field, or envelope. This is true not only of three wires, but of any other number, no matter how great that number may be. In Fig. 9 we show a short coil made of a few turns of large wire, and as is shown, the lines of force pass around all the turns of the coil simply because through all the turns the direction of flow of the electric current is the same, as is clearly shown by the arrows. A magnetic needle placed on top of the coil, as shown at *B*, would be drawn into a position parallel with the axis of the coil, with its north end pointing in the same direction as the arrow heads on the lines of force outside of the coil. This same needle if placed within the coil would point upward, which, as will be seen, is in accord with the same law as applies to a single wire. If there were no loss of magnetic strength when a number of wires carrying currents in the same direction are placed side by side, as is the case when a wire is formed into a coil, then the magnetic envelope surrounding two wires would be twice as strong as that of one wire, and for three, four or more wires the strength would increase directly in proportion with the number of wires. In practice, however, all the lines of force of all the wires do not combine to form a single magnetic field around the wires, but some of the lines of each wire circulate in local circuits, as is clearly indicated in Fig. 6; hence, the combined magnetic force is always less than the sum of all the single wire envelopes. The closer together the wires the smaller the local envelopes, as can easily be understood from looking at Fig. 6; therefore, the nearer the magnetic field of the coil approaches the sum of the magnetic fields of all the turns taken individually. This difference between the sum of the fields of the several turns of wire, and the actual field of the coil itself, represents a loss of magnetism that is called magnetic leakage, and although it can be reduced to a very small percentage of the total, by proper construction, it cannot be entirely eliminated.

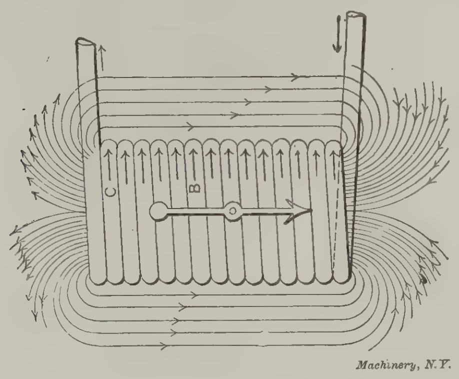


Fig. 9. The Magnetic Envelope of a Coil.

No Magnetic Insulator Known.

As we have already shown some forms of matter conduct electricity with so little resistance that they are classified under the head of conductors, while others have such high resistance that they are called insulators, as for all practical purposes they stop off the flow of current entirely. All metals are electric conductors, also all acids, most of the compounds of acids, and some solids that are not metallic. The greater portion of the forms of matter found in nature, however, are very poor electric conductors, if not actual insulators. With respect to magnetism the case is quite different; there is no substance in nature, as far as known, and no manufactured product that is an insulator of magnetism. Some forms of matter are better magnetic conductors than others, but the difference between the best and the poorest is very small when compared with the difference between electrical conductors, for the best of the latter are many thousands of million times better than the poorest, while the best magnetic conductors are only a couple of thousand times better than the poorest. The best magnetic conductors are iron and steel. Soft wrought and certain grades of steel specially made for use in electric machinery are at the head of the list. Cast iron is not as good a conductor as wrought, and high-grade steel is inferior to cast iron.

The magnetic conductivity of any substance is called its magnetic permeability. Copper, lead, brass, tin, wood, air, and in fact almost all substances met in everyday life are of about the same magnetic permeability. Nickel and cobalt have a slightly higher permeability than air, but are far below the most inferior grades of iron.

Greatest Density of Magnetic Lines of Force in Substances of Greatest Permeability.

Inasmuch as there are no magnetic insulators, it can be seen that the action of magnetism cannot be confined to a certain space by surrounding that space with an insulating casing, but somewhat similar results can be obtained by making the space in which it is desired to confine the magnetism of material of the highest permeability, so that the lines of force may be drawn into this space on account of the smaller resistance they encounter. Looking at Fig. 9, it can be seen that all the lines of force developed by the current flowing through the coil must pass through the space within the coil. On the outside of the coil the lines of force have unlimited space in which to circulate. In the diagram only a few of the lines are drawn as closed loops, all the others being broken off above and below the coil; this has been done because it would not be practical to make all the lines closed loops, but it must be remembered that in using lines to represent the magnetic force that surrounds a wire, whether this be straight or formed into a coil of any shape, these lines are supposed to be closed loops. The bunching of these lines of force as they enter the coil at once creates the impression that their passage through the contracted space must be resisted to a much greater extent than it is through the open space surroundng the coil; and this is actually the case. At the same time the crowding of the lines within the coil intensifies the magnetic force in this space, so that if a piece of iron be brought near either end of the coil it will be attracted with considerable force, while if it is removed a few inches from the end, the attractive force will be decidedly reduced. As the resistance to the passage of the lines of force through the coil is greatly increased on account of the crowding, the actual number of lines of force, or in other words, the total magnetism passing through the coil, is less than the total magnetism that would surround the same wire if it were run out into a straight line, or even if it were made into a coil with half the number of turns, and a correspondingly increased diameter. If the space within the coil is filled with a material that has higher magnetic permeability—conductivity—than the air, then the total number of lines of force that will pass through it will be increased for the simple reason that the resistance to their passage has been reduced. Thus if we insert a core of soft wrought iron into the coil, as shown in Fig. 10, the attractive force of the ends of this core will be many times greater than that of the ends of the coil alone. As the permeability of the iron core may be several hundred times greater than that of the air it displaces, the increase in the lines of force will be in like proportion, so that if the ends of the coil in Fig. 9 can hold up say one ounce of iron, the ends of the iron core in Fig. 10

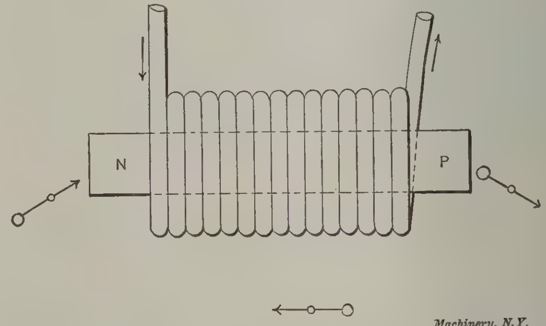


Fig. 10. Iron Core inserted in Coil, increasing the Magnetic Flux.

may hold up one hundred or more ounces. It is not possible to say just what difference in the strength of the magnetic field of the coil will be produced by inserting an iron core, as in Fig. 10, except by going into a very elaborate calculation, because the permeability of iron is not uniform for all strengths of the magnetic field passing through it. The total number of lines of force that pass through the center of a coil is called the magnetic flux, and the word magnetic field is only used to indicate the portion of the air space through which this flux passes, in which the magnetic force is utilized; hence, hereafter we will speak of the total number of lines of force surrounding a coil as the magnetic flux. The strength of the magnetism is spoken of as its density.

In the interior of the coil, Fig. 9, the density of magnetization is much higher than at any other point traversed by the lines of force, because at all other points the lines are more spread out. The magnetic force required to drive the

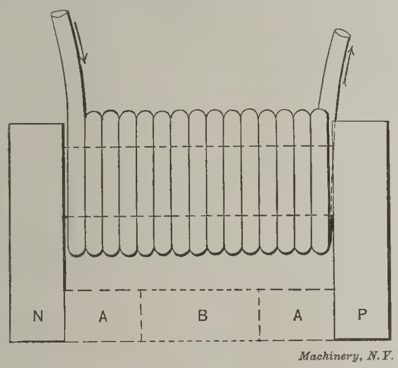


Fig. 11. Example of Means for Increasing the Magnetic Flux to a Maximum

flux through the magnetic circuit increases directly as the density, therefore by far the greater portion of the force is expended in driving the flux through the interior of the coil when there is no iron core within the coil. This force that drives the flux through the circuit is called the magnetomotive force, and it is developed by the magnetizing force of the current that passes through the wire coil. The total flux of the coil, Fig. 10, is much greater than that of Fig. 9, notwithstanding that in both cases the same coil is used with the same strength of current, because the iron core is of vastly greater permeability than the air it displaces.

The magnetic flux of Fig. 10 can be further increased by adding extensions to the iron core, as shown in Fig. 11, by the poles *P* and *N*. This addition increases the flux because it reduces the length of the lines of force through the air, and replaces a considerable length of the air circuit by iron. The addition of the iron blocks, *A* to *P* and *N*, will further increase the flux, as more of the air space of low permeability is replaced by iron of high permeability. If the remaining space is filled with an iron block *B*, so as to form a complete iron magnetic circuit, the flux will be increased to the maximum amount obtainable from the coil and the current passed through it. In this final construction it can be seen that practically all the magnetic flux will be confined to the iron core, thus while we have not been able to confine the magnetism by covering the magnetic circuit with an insulating material, we have been able to practically confine it by providing a path of such high permeability that nearly all the lines of force will follow it. In actual machines it is not practicable, except in a few cases, to use a complete iron magnetic circuit, but in every case, as we shall point out in describing actual machines, the designer makes an effort to come as near to a closed circuit as possible, unless there be some reason for not doing so, and generally he succeeds in doing it very effectually.

* * *

The shipment of 2,000 tons of iron ore from South Australia to Europe, which is the first shipment of this kind from the southern hemisphere, marks the commencement of a new chapter in the industrial history of the Australian commonwealth. Iron ore is distributed over the whole of Australia, and the deposits in several places are exceptionally large, but little use has hitherto been made of the ore.—*Mining World.*

THE ACTUAL EFFICIENCY OF A MODERN LOCOMOTIVE.—2.*

7. Hauling Capacity and Cost per Ton Mile.

The hauling capacity may be considered as a definite quantity, depending entirely upon the design of the engine. Assuming that the boilers of engines twenty years ago were as well proportioned for the work the cylinder would do as they are to-day, the hauling capacity is fixed by the size of the cylinder and wheels, or in other words, by the tractive power.

In the following table are given the weights on drivers and tractive power of representative passenger and freight engines built in 1893, comparing them with engines built in 1904.

Comparison of Tractive Power, 1893 and 1904.

PASSENGER, 1893.

Type.	Weight on Drivers.	Tractive Power.
American type simple	75,210	17,270
American type compound	83,860	12,900
American type simple	64,560	15,550
American type compound	78,480	14,050
Ten-wheel type compound	93,850	16,480

Average tractive power, 15,250 pounds.

FREIGHT, 1893.

Consolidation compound	120,600	22,950
Ten-wheel simple	101,000	23,310
Mogul simple	91,340	21,030
Decapod compound	172,000	35,580

Average tractive power, 25,720 pounds.

PASSENGER, 1904.

Atlantic type compound	101,420	22,180
Atlantic type simple	103,600	16,420
Pacific type simple	141,290	29,910
Pacific type simple	114,890	25,610
Atlantic type simple	80,930	25,590

Average tractive power, 23,740 pounds.

FREIGHT, 1904.

Santa Fe compound	234,580	62,740
Consolidation 2-cyl. compound	166,000	40,300
Consolidation simple	151,490	40,720
Consolidation simple	171,460	44,080
Consolidation simple	165,770	45,170

Average tractive power, 46,600 pounds.

The tractive effort of passenger engines has increased from 15,250 to 23,740, or 55.6 per cent; of freight engines, from 25,720 to 46,600, or 81.2 per cent. These figure show an enormous increase in size of locomotives in use to-day over those employed twenty years ago. During this time, however, but few railroads have seen any material improvement in the roundhouse facilities or shop equipment, and it is a grand tribute to the mechanical officers of railroads that repairs have been kept as low as they have.

During this period compound engines have also been introduced, and statement of their increased cost of maintenance has very frequently been due to an increase in size of the power rather than to the compound features.

There have been compilations made of the average weight of trains in tons (2,000 pounds) hauled by certain American roads during a period from 1895 to 1905. These figures include branches as well as main lines, and also exclude the tare weight of the cars, so that the tonnage actually hauled by the locomotives in through freight trains will be very much greater.

AVERAGE WEIGHT OF TRAIN IN AMERICAN TONS.

Eastern.	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904
Lehigh Valley	...	...	...	412	424	448	467	464	486	486
New York Central	...	...	290	320	361	398	392	387	421	419
Pennsylvania	...	...	...	...	470	478	489	518	527	...
Southern.										
L. & N.	...	...	179	194	216	239	222	231	231	234
N. & W.	...	...	325	355	384	435	452	476	486	488
C. & O.	...	325	352	379	450	500	533	538	...	536
Southern	...	162	173	176	188	203	222	226	218	225
Central.										
Illinois Central	...	...	194	191	209	222	275	325	335	332
Chi. & N. W.	...	141	152	194	208	236	232	250	232	...
C. M. & S. P.	152	167	167	175	187	205	263	285	281	280
L. S. & M. S.	318	322	321	352	427	455	531	577	615	...
Western.										
South. Pacific	...	...	...	220	226	240	254	261	267	...
North. Pacific	...	...	230	313	336	391	381	401	384	403
Gt. Northern	...	256	281	316	336	357	381	418	447	447

* Abstract of paper read by Wm Penn Evans before the Pacific Coast Railway Club, March 17, 1906.

This table of actual train loads shows what has been done with the power available, part of it being light power built some time ago, and part the modern heavy power. The train loads have actually increased from 229 tons in 1896 to 385 tons in 1904, or 68 per cent.

With an increase of tractive effort of 55.6 and 81.2 per cent for passenger and freight engines in ten years, the train loads actually hauled have increased 68 per cent. These figures agree surprisingly well, which is coincidence, because there are a great many considerations other than engine power which go to make up the average tonnage of trains hauled for a year.

8. The Cost Per Ton Mile.

The cost per ton mile is an important one as it is the means used by all railroad officials in making comparisons of one month or year with another, or one division with another, or, in fact, in the computation of any transportation charges.

The cost of hauling trains per ton mile has been tabulated for the same period for which the tonnage hauled was given, and shows the effect partially due to enlargement of trains. We say partial, as there are many other items besides the train loads which offset this cost, as the variation in price of materials, labor, etc. Such increases have occurred principally within the last five years, and it will be seen that generally the cost has risen in this period while it fell before. But we also see that the greatest increase in tonnage per train was made in the previous five years.

Average Cost of Transportation per Ton Mile in Cents.

Eastern.	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904
Lehigh Valley	..	.43	.42	.35	.40	.42	.41	.41	.43	.40
N. Y. Central	..	..	..	.39	.35	.35	.38	.42	.44	.48
Pennsylvania	..	..	..	..	.34	.36	.38	.40	.43	..
Southern.										
L. & N.	..	..	.58	.54	.52	.54	.50	.51	.54	.55
N. & W.	..	..	.33	.28	.27	.26	.28	.27	.29	.31
C. & O.	..	.28	.27	.24	.23	.22	.24	.25	..	.31
Southern	..	.68	.65	.64	.63	.64	.66	.66	.70	.69
Central.										
Illinois Central	..	..	.44	.44	.45	.43	.41	.40	.39	.43
Chi. & N. W.	..	.63	.60	.56	.54	.50	.51	.50	.55	..
C. M. & S. P.	.67	.60	.61	.61	.59	.63	.57	.56	.58	.59
L. S. & M. S.	.39	.37	.37	.34	.32	.33	.34	.38	.41	..
Western.										
South. Pacific	..	..	..	.62	.62	.64	.64	.66	.68	..
North. Pacific	..	..	.70	.50	.50	.47	.48	.46	.47	.46
Gt. Northern	..	.51	.53	.44	.45	.46	.48	.42	.42	.46

Examine, for instance, the record for the Northern Pacific, the cost dropped from 0.70 to 0.47 between 1897 and 1900, and the tonnage per train increased from 230 to 391 in the same time; whereas, from 1900 to 1904, the load has only increased from 391 to 403 (12 tons) and the cost has been reduced only one point, that is, from 0.47 to 0.46 cent.

Also for the Chicago, Milwaukee & St. Paul from 1895 to 1902, the train load increased from 152 to 285 tons, nearly double, and the cost dropped from 0.67 to 0.56, but since then the train load has decreased slightly and the cost has risen to 0.59. In this case again the lowest cost is accompanied by the heaviest train. Other roads, however, show an increased cost (generally slight), although the train load has become slightly heavier, this being due, no doubt, to the greater charges for labor and material. If we now return to the table of train weights, we will see what enormous strides some of the lines have made in introducing heavier trains. The Lake Shore & Michigan Southern has increased from 318 to 615 tons in eight years, or nearly double, and the Chicago, Milwaukee & St. Paul has accomplished nearly as much in proportion, but its average train load now is not as great as the Lake Shore's was ten years ago. This is accounted for by the fact that the Lake Shore is nearly straight, with maximum grades of eighteen feet per mile, while the Milwaukee has grades possibly three times as steep, and numerous branch lines of light traffic.

We must not confuse these train loads, however, with what is really hauled by the locomotives, as the Lake Shore has engines which can pull 3,000 tons or more back of the tender. As stated above, the figures are the average train loads for main lines and branches, and, moreover, do not include the weights of the cars themselves, which may be from one-half to one and one-half times the load, depending on whether it is heavy (like coal and ore) or bulky (like some classes of merchandise, such as furniture). One of the transcontinental lines recently so grouped its power that it could move trains from 1,350 to 2,600 tons west-bound; that is, the train load back of the tender lay between these limits for different portions of the line, the locomotives being located according to the grades encountered, the idea being to maintain a constant train load as far as possible.

9. Reliability of Service.

This division of the subject is taken to mean the number of engine failures as related to the trains run both twenty years ago and to-day.

First it will be well to discuss what is meant by an engine failure. Some roads report as an engine failure anything whatever that delays a train over two minutes on the road, which is chargeable in any way to the locomotive, whether or not such time was subsequently made up. Other roads count only breakdowns. The Chicago & Northwestern Railway has made the definitions of an "engine failure" the subject of an official circular, which has been in effect several years.

1. All delays waiting for an engine at an initial terminal, except in cases where an engine must be turned and does not arrive in time to be dispatched and cared for before leaving time.

2. All delays on account of engines breaking down, running hot, not steaming well, or having to reduce tonnage on account of defective engine, making a delay at a terminal, a meeting point, a junction, or delaying other traffic.

The first case could not have been any different with engines twenty years ago than to-day. The second, which embraces breakdowns, hot boxes, and failures for steam, are chargeable more to the engine than are delays at initial terminals, but even these are not always the fault of the engine or crew. You all know of cases where engineers have reported loose eccentrics time and time again, but because the cams would have to be taken off and reduced, nothing was done but tighten a setscrew, perhaps. Then the eccentric shears off a key and slips around. The engine may limp into the next division point, but there is a breakdown charged against the engine and crew, when the roundhouse foreman or some higher authority was more responsible than the crew. In general, the reason engines of to-day would be more or less reliable than those of twenty years ago is on account of the service they have to perform and the care taken of them, and the use of material better adapted to the special service in which it is used. The higher speeds of to-day are hard on the engine. The excessive loading which some trainmasters expect a freight-engine to handle often accounts for a failure which would not have occurred had the engine been more properly rated.

The use of cast steel driving tires and centers in place of cast iron, of steel boiler plates in place of laminated iron, of high carbon forgings for axles, pins, and rods in place of case-hardened iron, has tended to materially increase the reliability of the engine of to-day as well as to decrease the cost of maintenance. The care used in the selection and inspection of material, and the corps of trained chemists and metallurgists maintained by the large manufacturing plants of to-day have all assisted to this end.

The art of building locomotives may progress unevenly, that is, a fault may creep into all engines built for a certain period of years which is due to the use of the same design or method of manufacture when it no longer produces a satisfactory product. When the fault is recognized, the method, material, or design is changed and a finer article is produced than ever before, only to make some other part seem unsatisfactory in comparison.

To show where the new power is more satisfactory than the old, the following experience may be cited. For a long time the service between certain points was erratic. The trains were hauled by eight-wheeled engines, which were too small to make time with the trains put behind them. Being old, they were subject to frequent breakdowns on the road. In their youth these engines had done the work expected of them. The trains were less and less regular, until a sufficient number

of powerful ten-wheel engines was purchased, and the trains are now run so that the officials are proud of the railroad's record of scarcity of train delays from engine failures.

10. **Hours Lost by Being Held for Shop Repairs.**

This may be said to have nothing to do with the size of the engine. Of course, in any modern shop the small engines of fifteen years ago which are still running can be repaired with much less labor than the modern power, but the biggest engines are given a complete overhauling to-day in less time than was necessary for any engines twenty years ago. In one

COST OF MAINTENANCE PER TON MILE.

Year.	Cost in Cents of Repairs per 1,000 Freight ton Miles.
1897	25.4
1898	23.9
1899	21.7
1900	20.3
1901	18.2
1902	21.6
1903	21.6

of the shops of the Northwest, where a proper system of shop management has been in conscientious operation for four or five years, the time of general repairs has been reduced from one month to thirteen days. The cost of maintenance has been reduced when based on the cost per ton mile as is shown by the table above for one of the Southeastern lines.

* * *

ONE CASE OF GRAFT CURED.

In a large eastern factory making a furniture specialty, the manager became convinced that all was not right in his finishing room. He heard in some manner of a factory, making varnish, that was said not to do any grafting. He sent for the manager of the varnish sales department and told him his suspicions and his troubles.

The two had a long talk, and the upshot was they agreed to trust each other; they were to eliminate the foreman finisher and the varnish salesman, and deal only with each other. When the manufacturer wanted some varnish he was to let the varnish man know, and was not to be bothered by the varnish salesman calling on him. On this basis there was a saving of 17½ per cent on the varnish alone, over what the man had been paying. Things ran along smoothly for a couple of months, when one day the varnish man got a wire from the manufacturer to come to the factory at once. On his arrival there he was told that his varnish had gone wrong.

"Guess not," was the laconic reply. "May I go up into the finishing room?"

"Certainly," said the manufacturer.

The varnish man was wise. He had been all through the business; had been a foreman finisher himself, and had been on the road a great many years before taking his present position. He went to the finishing room, and, after greeting the foreman finisher, asked what the matter was.

"Don't know," said that gentleman, "only that the stuff has gone wrong."

"Now, let me tell you something, Charley," said the wise salesman. "That stuff is all right. I know it, because I know just how it is made. I know just what it will do and what it will not do. Now, I can make another test to please the manager, but if I do you will be out of a job. You have a good job, the best one you ever had, and, as I say, if I have to go to the trouble of making another test, you will be out."

"Are you a big enough man for that?"

"I certainly am, Charley. Mr. Blank, the manager, is onto you, and if I show him just one little crooked thing about you, you will walk the plank."

That was two years ago or more, and nothing has since gone wrong with the varnish.—*The Woodworker.*

Fig. 1. Forty-ton Bogie Well Car.

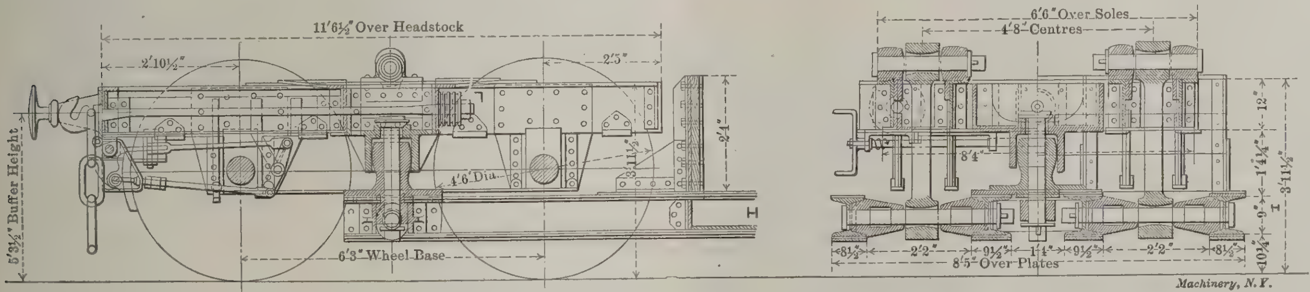


Fig. 2. Details of Forty-ton Bogie Well Car.

A SPECIAL ENGLISH FORTY-TON BOGIE WELL CAR.

For the conveyance of large boilers and extremely heavy castings, as well as other machinery of unusual proportions, a new type of bogie well car has been designed by J. G. Robinson, the mechanical engineer of the Great Central Railway Co., England, for use on the Cheshire line. This 40-ton car was built at Leeds, England, by the Leeds Forge Co., Ltd., and the construction and details are shown in the accompanying illustration, Fig. 1, and line cut, Fig. 2. It has a total length over all of 59¼ feet, with a width of 7¼ feet over the head stops. The car is fitted with a hand brake on one bogie, the brake block being applied to each of the two wheels, while the other bogie has no brake provided. It is stated that this car will carry 80,000 pounds if loaded to its full capacity, and 25 tons if loaded with a central space of 12 feet.

The length of the well is 32 feet and the width of the same 7 feet 5 inches, while 20½ inches is the distance from the floor of the car to the rail level; the distance between the centers of the buffers is 5 feet 8½ inches, while the height of the buffers is 3 feet 5½ inches. It will be noted from the cuts that there are two four-wheeled bogies having their centers a trifle less than 40 feet apart. The wheels are 54 inches in diameter on the track, while the bogie wheel base measures 6 feet 3 inches. Both on the inside and outside wheels the journals are 5½ inches by 8 inches. It has been stated that this English 40-ton well bogie car has been found of great value in handling loads which would be inconvenient on other forms of cars. F. C. P.

GERMAN EIGHT-COUPLED FREIGHT ENGINE, WITH SMOKE CONSUMER.

FRANK C. PERKINS.

A new type of freight locomotive has recently been constructed at the Hanover-Linden Locomotive works in Germany by the Hanoverische-Maschinenbau-Actien-Gesellschaft and placed in operation on the Prussian State Railways. The accompanying illustrations show its general features.

Fig. 1. German Eight-coupled Freight Engine with Smoke Consumer.

The spacious cab of the compound freight engine will be noted as well as the arrangement of the boiler fittings and Simon's central lubricator. This locomotive works on the two-cylinder compound principle, Dultz's change valve being used for the starting mechanism. This valve allows of the shunting by hand of the cylinder from the twin on to the compound mechanism, or *vice versa* as desired. The valve gear is constructed on the Allan system and the piston stroke measures 24.8 inches, the low-pressure cylinder being 29.5 inches in diameter and the high-pressure cylinder 20.8 inches in diameter.

An overhead lantern and ventilating flap are fixed on the ceiling, while a smoke reducing apparatus is attached to the firebox door on the Langer-Marcotty system. This device consists in the main of two hollow stays with nozzle heads right and left above the stoke hole. When the smoke-reducing apparatus is in operation, jets of steam are blown across the fire, through the two nozzles above mentioned, and extend over the fire in the form of a veil. A mixture of fire

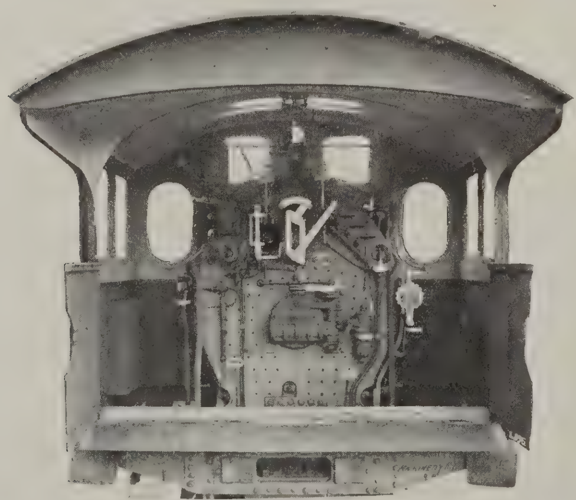


Fig. 2. Inside of Cab, German Eight-coupled Freight Engine.

gases with the air in the upper part of the firebox is thus produced and prevents the former from rising to the tube plates of the combustion chamber. In this way the complete combustion of both fuel and smoke is assured.

This compound engine has eight driving wheels 44¼ inches in diameter, and a total wheel base of 14 feet 9⅛ inches. The boiler supplies steam at a pressure of 175 pounds and has a total heating surface of 1,640 square feet, with a grate area of 24¼ square feet. The engine without the tender and without fuel and water weighs 46.37 tons, and when ready for operation has an adhesive weight of 52.6 tons. The tender when in working order weighs 32.1 tons and when empty 15.1 tons. It is provided with water tanks having a capacity of 423.6 cubic feet, and has coal bunkers capable of holding 5 tons of fuel.

* * *

ELECTRICAL NIGHT OF THE NEW YORK RAILROAD CLUB.

The March 15 meeting of the New York Railroad Club held in the New Engineering Societies Building, New York, was the electrical meeting, ten-minute papers being contributed by various members celebrated for their achievement in electrical railway work. Two of the papers, those of Messrs. Wilgus and Sprague were defensive of the electric locomotive equipment built for the New York Central suburban service. The defense was in regard to the terrible wreck in which twenty-four people were killed near Woodlawn, N. Y., on February 16. Mr. Sprague contended that the low center of gravity—44 inches above the rails—was amply high for any practical requirements, and that the extensive tests to which the trial electric locomotive had been subjected should have developed any serious mechanical defects. He and Mr. Wilgus both said that in no engineering work had the apparatus been subjected to such severe preliminary trials as these electric locomotives. Hence, they denied *in toto* that the mechanical construction or third rail could have been in any way responsible for the wreck.

Referring to the steam locomotive and the lessons learned in its development, Mr. Samuel Vauclain, superintendent of the Baldwin Locomotive Works, spoke in a sarcastically good-humored way and rather ridiculed the methods of the electrical experts in developing electric locomotives. He intimated that they had been very slow to accept the lessons learned in steam locomotive practice, and that until they did accept those lessons they were bound to see a great deal of trouble and hardship. In the electric locomotive of the New York Central type each driver represents from 12,000 to 13,000 pounds of dead weight which is not spring supported. In Mr. Vauclain's opinion any electric locomotive built on this plan is bound to cause serious difficulties. He spoke in favor of the Simplon tunnel type of electric locomotive in which the motors are mounted high above the drivers and connected thereto by a system of connecting-rods. In this manner more room is made available for the motor equipment, and the center of gravity is elevated, thereby making the locomotives easier riding and less destructive to the track, especially on curves. This lesson of elevating the center of gravity so as to reduce the lateral effect of locomotives on curves was learned incidentally with the development of the Wooten type. The efforts of early locomotive designers had been almost constantly to keep the center of gravity as low as possible, the designers thinking thereby to diminish the danger of a locomotive overturning on curves and bad track. When the first Wooten locomotives were built having the boiler hung over the wheels and greatly elevated, many practical locomotive men were seriously alarmed for the consequence. They anticipated that a locomotive with such a high center of gravity would roll over on the first sharp curve it struck when running at high speed, but contrary to these delusions it was found that not only did the engines round the curves easier, but the lateral effect on the curves was less than with locomotives having a low center of gravity. The reason for this was easy to see when it had once been demonstrated. The side thrust of the locomotive with a high center of gravity and its weight are resolved into a component at a greater angle to the track than with a low center of gravity thus throwing more vertical stress on the rail and tending to hold it more securely to the ties.

* * *

An 8,000 I. H. P. rolling mill engine was recently installed in the Edgar Thompson Works, Pittsburg, Pa., within ten days after shutting down the mill. During this time the old engine had to be torn out. The work was pushed forward without stopping, using three shifts of men. After the completion of the actual work of installation, the new engine was doing full work rolling steel rails within thirty minutes after steam was first let into the cylinders.

AUTOMOBILE ENGINE BUILDING IN A STEAM ENGINE PLANT.

The business of the Providence Engineering Works, of Providence, R. I., is ordinarily that of building heavy mill and power plant engines. During a temporary lull in this line, two years ago or thereabouts, the management of the firm decided to take on some contract work. Arrangements were accordingly made with the Maxwell-Briscoe Motor Co to manufacture about two thousand double-opposed-cylinder automobile gas engines, with the accompanying speed change mechanism, differential gearing, and other related parts.

A period of careful planning and hard work followed the signing of this automobile engine contract. New machinery had to be purchased at a time when it was almost impossible to get machinery of the kind required. New workmen, skilled in special operations, had to be hired at a time when good workmen were being bid for in a very lively fashion. Difficulties of this sort, however, were overcome with a little time and patience. Meanwhile the superintendent, shop foreman, and an expert tool designer, set themselves to the task of carefully going over the detail drawings of the engine they were

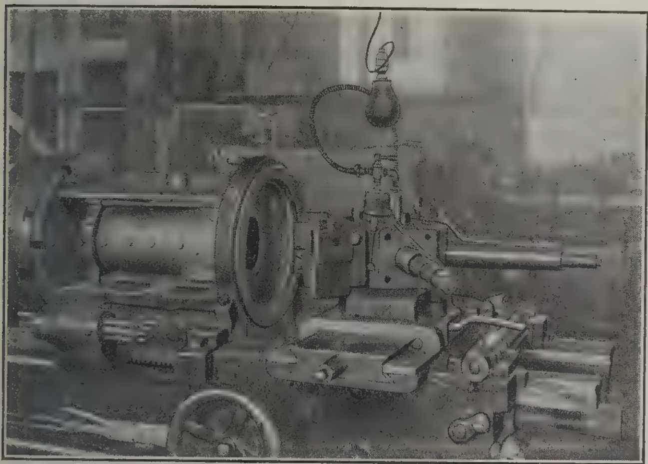


Fig. 1. Reversible Revolving Fixture for Boring Crank and Transmission Cases.

to manufacture, taking up each part in turn and deciding on the order of operations for each, and the tools that were to be used on it. After due conference on the matter an operation sheet was written up for each piece, giving in the first column the number and name of each operation performed, no matter how simple; in the second column the holding tools required for that operation, such as jigs, fixtures, clamps, etc.; in the third column the cutting tools used in the machine; and in the fourth column the testing gages and devices used by the inspector.

In cases of this kind there is a great temptation to commence work before such elaborate preparations as those just outlined have been completed. With the customer anxious for finished work at the earliest possible moment, and with what appears to be a heavy non-productive preparatory expense staring the management in the face, it takes some courage to refrain from trying to start production with the usual haphazard ways of working. It must be admitted that this temptation was yielded to in a slight degree. In the matter of test tools, for instance, the pressure on the drafting room and toolmaking force was such that production had commenced before the measuring devices were completed, so that the inspectors were left in many cases to somewhat clumsy, though accurate methods of passing on work performed. In general, however, it may be stated that the ideal of thorough preparation was conscientiously held to.

Simultaneously with this work of determining the manufacturing methods, there was developed a system of cost keeping simple enough to be practicable, and yet complete enough to inform the management at any time as to the exact cost of each part and the comparative cost of the same part in different lots. The system also kept account of all the stock and castings used, leaving no chance for spoiled work to escape attention, and always assuring the full complement of parts when a lot was to be assembled. A great factor in making this last item possible was the thorough inspection planned for, which required that every individual part be tested after each operation, or group of related operations. With this precaution, the expenditure of costly work on already spoiled pieces is avoided, and provisions can be made for replacing spoiled work before it reaches the assembling room, where a shortage will often cause a very costly delay.

It was impossible, in the comparatively short time the writer was able to spend at the plant, to see all the interesting methods of manufacture involved, and it is still more impossible to describe them in the limited space at his disposal in this journal. The best that can be done, perhaps, is to describe a few of the operations which particularly attracted the writer's notice, and let the reader judge therefrom as to the nature of the rest of the work.

The engine called for in the contract is of the double opposed cylinder type, with a crank case and transmission gear case in one piece. The cam shaft is driven from the crankshaft by spur gearing, and is journaled in a frame which also carries the tappet rods and their springs, by which the valves are operated. The arrangement of the mechanism is such that a single inlet cam and a single exhaust cam serve to control the valve movements of both cylinders. The frame containing the mechanism is bolted to the top of the crank case, and may be quickly removed entire, thus affording access to the crank chamber. The speed changing mechanism is of the epicyclic type, giving two forward speeds and one reverse. The clutch is of the multiple disk design, running in oil. All this mechanism forms a complete power unit; the complete structure is supported on a three-point bearing, the cylinders being supported at their heads by the side bars, while the rear end of the transmission case rests on a cross brace of the frame. This design assures permanency of alignment as well as simplicity of construction.

The gear and crank casing, which is of aluminum, first undergoes a milling operation for the cover and for the bolting on of the plate by which the speed changing levers are held.

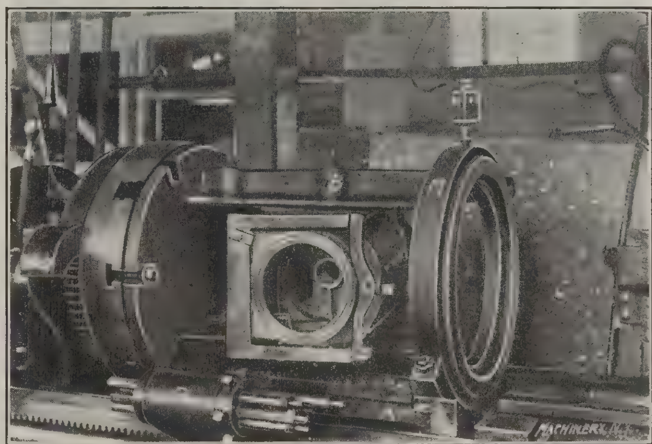


Fig. 2. Work being Swung End for End in Boring Fixture.

This operation leaves a square finished corner whose sides are used as gaging surfaces for subsequent operations. The crankshaft is journaled in a bearing cast integral with the case near its center, the outer ends being supported in bearings in two heads which are clamped to seats finished for them. The boring and facing of the boss for the central bearing and of the seats for the heads or covers at either end, is accomplished in an ingenious fixture attached to the faceplate of a heavy Bullard turret lathe. This fixture is shown in Figs. 1 and 2. The work is held by its finished surfaces with hook bolts and is lined up by suitable setscrews. Straps *C C* are swung over the top of the case, and the setscrews which they carry are brought lightly down on top of the work. The outer end of the fixture is carried in the steady rest *M*, which is clamped to the bed of the lathe. The following operations then are performed. First, at the cylinder end a single pointed boring tool is run through the boss for the central bearing. The hub is then faced and the hole chamfered to form a true starting surface for the 4-lipped drill which is located in the next station of the turret. The

third and fourth operations are the roughing and finishing cuts for boring, facing and grooving the flange at the cylinder end. The blades for this are set in heavy cast-iron holders, one of which is in position for action in Fig. 1.

The cylinder end having been finished, the unique feature of the fixture comes into play. The locating pin *A* is withdrawn and the whole transmission case casting, with the fixture in which it is held, is revolved about a vertical axis passing through pivots *B*, until the transmission end is brought to the front to be worked on. This change of ends is shown half completed in Fig. 2. The other end of the hub is now faced, and the flange at the transmission end is finished with the same tools used for the crank end.

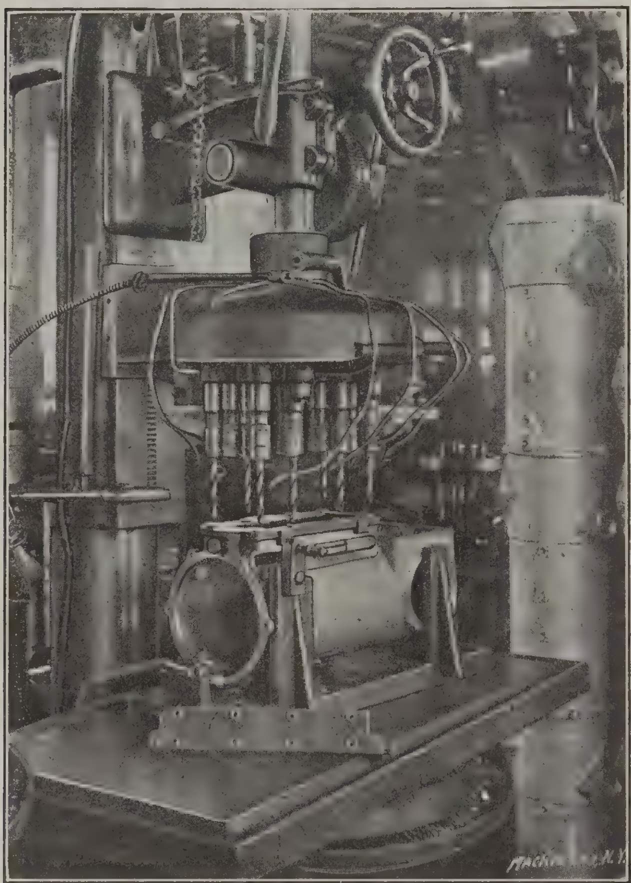


Fig. 3. A Multiple Spindle Drilling Head arranged for Two Lay-outs.

The steady rest, as shown, is provided with a sight feed lubricator. Some little difficulty was experienced at first with the bearing at this point; the final and successful form of bearing was cast-iron running on babbitt, with overhanging lips provided on the journal on each side of the bearing, to prevent intrusion of chips and grit. Fastened to the ways in front of the fixture will be seen a series of stops inserted in a revolving holder *D*. These are used for determining the length of cut for the various operations.

One of the succeeding operations on this part is shown in Fig. 3. A multiple spindle drilling attachment is there shown, attached to a Prentice drill press. This attachment was built by the Langelier Mfg. Co., of Providence, R. I.; it is of interesting construction though in no sense new. We may at a later date show something of its details. The interesting feature of this particular multiple spindle drilling attachment is the fact that it was built for two operations. As shown, it is set up for drilling the bolt holes for the cover plate. There are, however, it will be noted, two inner rows of spindles which are not being used. These are employed for a later operation, the drilling of the bolt holes for the slide cover shown near the top of the front side of the casting; the bushing plate for this is lying on the drill press table in the foreground of Fig. 3. One attachment at a moderately increased cost thus serves for two operations. In a similar way the two end flanges and the cylinder clamping surfaces are drilled with a second attachment, having for this purpose two rows of holes, only one of which is used at a time.

The fixture and tools shown in Fig. 4 were first passed by the writer without particular notice, although their purpose had been fully explained to him. After a night's meditation on the subject, however, the ingenuity of the idea involved in this fixture grew upon him to such an extent that he returned the next day for the photograph from which the cut was made. The operation being performed on this drill press comes next after the snagging. It has as its object the finishing of certain locating surfaces to be used in boring the cylinder. These surfaces must so locate the cylinder in the boring operation that the comparatively thin wall left will be of uniform thickness throughout the circumference at both top and bottom ends of the cylinders, and so, also, that the facing of the cylinder flange where it is attached to the crank case, will be such a distance from the rough rear cylinder end, that there will be the same compression space in each cylinder. The rough casting shown on the drill press bed at the left of Fig. 4 has set within it a templet whose lower end rests on the rough bottom of the cylinder. On the chalked outer edge of the hexagonal flange by which the casting is bolted to the casing, is scribed a line which coincides in its vertical location with the under edge of the overhanging lip of the templet. After this edge has been scribed, the casting is reversed and placed in the fixture under the drill spindle, as shown. This fixture consists of a base with an adjustable bottom plate and a series of brackets around the outside. The vertically adjustable seat on which the casting rests is moved up or down by a nut beneath the base of the fixture until the tapered point of a locating pin coincides with the line which was scratched on the casting from the templet, as previously described. There are also a series of locating pins *F*, eight in all, mounted at the top and bottom of the casting in brackets cast integrally with the bed. These pins may be clamped in position by the winged head screws shown. They all carry similar locating marks, which should line up with corresponding marks in recesses cut in the hubs which carry them, if the casting is central in the fixture and is of normal size.

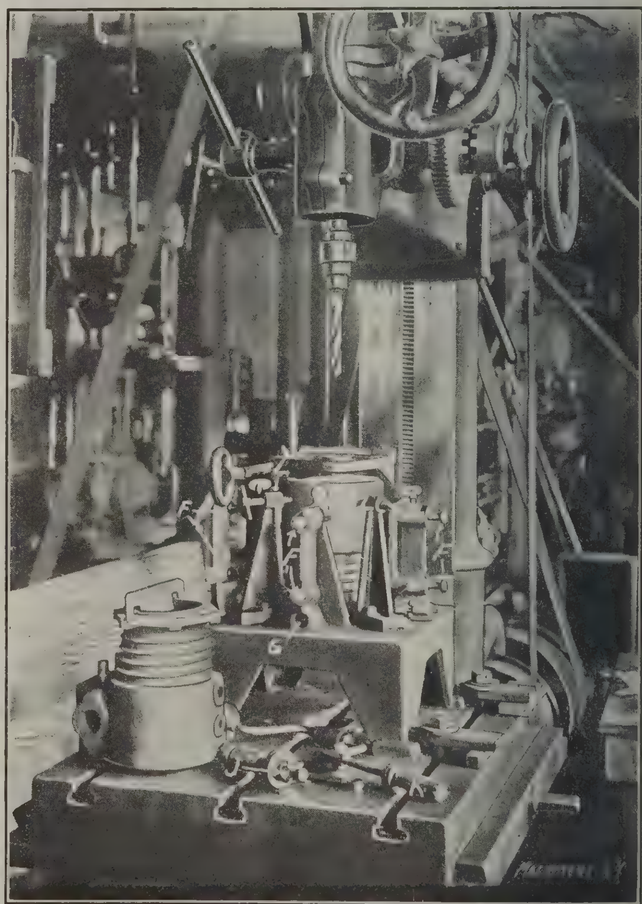


Fig. 4. Laying Out Templet and Spotting Fixture for Cylinders.

In locating a cylinder then, it is first adjusted vertically until the line scribed by the templet comes opposite the point of the gage pin; then it is centered at the bottom by

pushing in the various pins F until the marks on them line up with those on the jig (or until they are all equally out of alignment), when they are clamped by the thumb screws. This operation is repeated with the upper locating pins F, and the supplementary clamping screws L, on the intermediate brackets, are then brought down on the work to hold it more firmly. The hinged cover shown is next swung over, and a hole is drilled through into the top of the cylinder. The boss in which this hole is located is then faced by the counterbore J shown on the table below. This counterbore has a stop collar clamped to it to determine the depth of cut. The hole is intended primarily for the suspension bolt by which the cylinder is fastened to the frame, but its immediate use is, by its location, to fix the upper end of the cylinder in the subsequent boring operations; and by the depth of the counterboring of its hub, to determine the depth of the clearance space. At G, in the base of the front bracket, and in one of the intermediate brackets to the rear of the machine, are holes for guiding the hollow mill held in the bit-brace K, shown in the drawing. This hollow mill carries a stop which comes up against the face of the boss through which it passes, and limits the depth of the cut which may be made with it; the tool is, of course, worked by hand. It spots flats on two of the six corners of the hexagonal flange of the cylinder. These spotted off corners are used in lining up the outer end of the cylinder in the boring operation, which is thus assured of being properly done so far as the outer end is concerned. This device is, in fact, a laying out fixture rather than simply a drilling jig for the simple operation

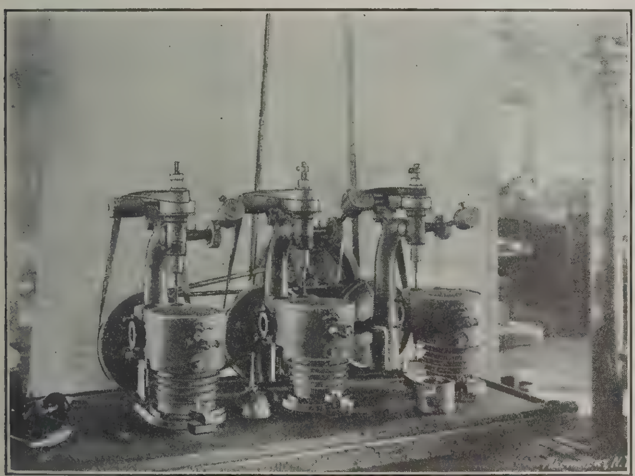


Fig. 5. Novel Machine for Grinding in Valves.

performed. Upon the location determined by it depends all the subsequent work done on the cylinder.

In Fig. 5 is shown a little device for grinding in the valves. This arrangement looks like a 3-spindle gang drill when at rest, and if the observer has once come to the conclusion that this is the case, the action of the rig when the shipper rod is thrown over is surprising—almost ridiculous even. Instead of whirling straight ahead as well-educated drill spindles should, those of this machine run in one direction for a few turns, then turn around and hurry backwards again, and so on. This reciprocating rotary motion is, of course, just what is required for grinding the valves to their seats. Each spindle carries a screwdriver-like implement at its lower end which engages a slot in the top of the valve stem. The belts which rotate the spindle back and forth are carried over the large pulleys at the rear, which are in turn given a reciprocating rotary movement by the driving pulley and connecting rod shown. But three of the six machines used on this bench appear in the cut. The man who formerly spent weary hours at the bench grinding in these valves with a bit-brace, is said to have become really cheerful under the new dispensation, where he has only to put the parts under the machine, put in a little oil and emery, and watch it do the work.

Considerable ingenuity is shown in the making of the pistons and piston rings. The pistons are finished on a Gridley turret lathe and are chucked by their rough inside surfaces in such a way as to bring the thickness of metal about the same all around the circumference. The chuck for this purpose is shown in Fig. 6. The piston is gripped by six pins which expand outwardly, three at the front and three at the rear. The bosses for the connecting rod pin interfere with placing these pins 120 degrees apart, but they are spaced as nearly that way as possible. It was not desired to have separate movements required for tightening the work at the front and back, so a floating device is used for clamping the work which, with but one movement, assures

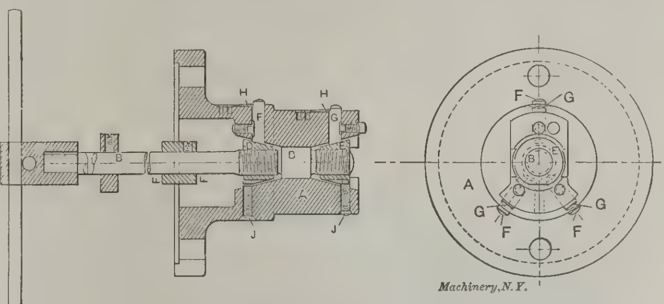


Fig. 6. Floating Grip Chuck for Piston.

the simultaneous outward movement of the six pins and gives an equal distribution of clamping effect between the front and rear groups. As will be seen in Fig. 6, the pins are moved outward by the tapered nuts D and E, threaded one right hand and the other left hand, on the closing rod B, which passes through the center of the spindle and ends in the cross handle C at the rear. Flat springs H normally keep the pins pressed down on these wedges. Suppose a piston is placed on the nose of the fixture. When the clamp rod is turned, the outer row of pins, G, may possibly open first. These will continue in their outward movement until they strike the rough interior of the piston, which is thereby centered at the front end. When the outward movement of these pins is thus arrested, the continued rotation of the clamping screw threads it into the outer tapered nut and thus brings the inner tapered nut toward the right, moving outward the three pins T of the second row. These in turn advance until they strike and center the rough interior of the piston at that end. The final forcible tightening of the six pins takes place simultaneously, the clamp rod and tapered nuts shifting longitudinally until the pressure is evenly distributed.

An equally interesting device is used on a special Gridley automatic turret lathe for making the eccentric piston rings. These are made in gangs of eight from a single casting, held in the chuck of the machine. The inside is bored true, and the outside is simultaneously turned eccentric by a tool mounted on a cross slide, which is moved in and out by a cam rotating in unison with the spindle. A bank of cutting-off tools then comes up, in which each succeeding blade is set a little behind the one that went before it. Thus, when the first ring

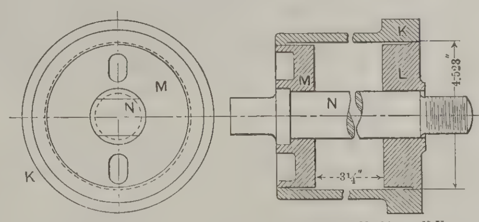


Fig. 7. A Neat Method of Grinding the Outside Diameter of Piston Rings.

has been cut off, the second ring is nearly severed, the third ring is well along, the fourth has been started, etc. The rings drop off in rapid succession one after the other, without waiting for the entire completion of the preceding cut.

In grinding the outside diameter of the piston rings, always a somewhat questionable operation, a method is followed which the writer does not remember ever to have seen used or described elsewhere, although it may not be new to some of our readers. The piston rings, which have by this time been split, and ground on a Heald grinder to accurate thickness, are now sprung one by one into the shell K of the fix-

ture shown in Fig. 7. This fixture is larger in diameter than the piston by the amount which is to be removed from the rings in the final grinding operation, so that these pieces are sprung by the same amount which they will be when in place and at work. When the shell has been filled, the arbor *N* and the rear flange *M* are inserted from the back, and the outer flange *L* is inserted from the front. The rings are then tightly clamped between these two flanges by a nut at the threaded end. The whole is then pushed out of the shell and taken to the grinding machine, where it is finished to the exact diameter of the cylinder bore. It is claimed that this arrangement gives rings which fit as well as could possibly be desired in the carefully-ground cylinders in which they are used.

Many other evidences of careful planning besides those

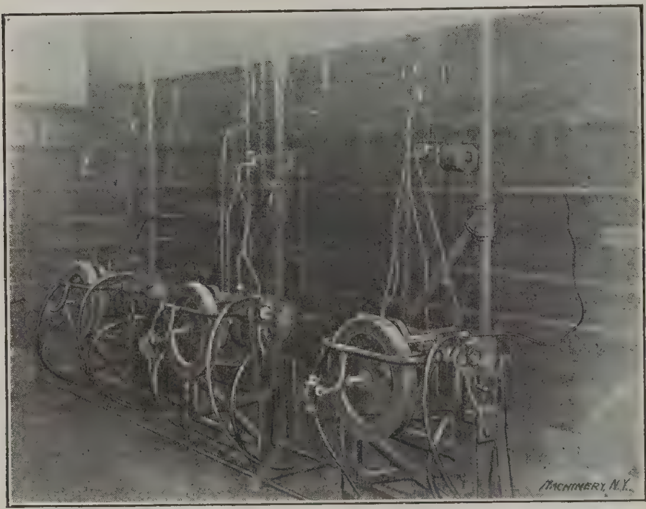


Fig. 8. A Corner of the Testing Room.

mentioned were noticed by the visitor. In the assembling department, for instance, special stands are provided in which the engines are put together. These may be adjusted to various positions to suit the part of the engine being worked on. Here the work of putting together a lot is done on the rotation plan; a workman in carefully prearranged order first attaches one part to each of the machines in the lot, then a second part, then a third—and so on. Certain men thus become skilled in the putting together of certain portions of machines, while the work progresses more rapidly than would be the case if the workmen stuck to one engine until he had it finished. Fig. 8 is taken in the testing room. It is difficult to get a good picture here owing to the dark location of the room and the amount of smoke present in the air. A row of four engines are here under test, the fourth one being just out of sight in the right foreground. There are four similar rows, giving room for 16 machines in all at one time. The building itself is of steel and corrugated iron. Special testing stands were designed for holding the engines. Neat arrangements for piping for gasoline, cooling water, and exhaust are provided, as well as for the ignition wiring and lubrication. Hoists are arranged for setting and removing the engines. All the machines are run here several hours before being finally passed, and the room is a very busy place when there are 16 engines running at from 1,500 to 2,000 revolutions per minute.

Perhaps what is said here in regard to the work at the Providence Engineering Works will still further emphasize the idea expressed in an editorial in the last issue of the Engineering Edition; namely, that sometimes it pays to give a great deal of thought and time and money to the matter of deciding just what you want to do before you commence doing it, even when the pressure for "showing results immediately" is very strong. Of course, with all this planning, some changes were found advisable in the method of manufacturing; besides the proportion of time spent in supervision and other "non-productive" labor may seem large; but the visitor cannot, nevertheless, escape the conclusion that the manager and men of this firm have done wonders in striking boldly out in a new line of work with only limited time at their disposal.

THE DISCIPLINE OF DEMOSTHENES McGINNIS.

THE HIRED MAN.

Demosthenes McGinnis was principal owner, and manager of the machine shop in Helvertown. The shop was on the bank of "the river" which was about 6 inches deep in some places, and less in all other places, which fact did not prevent Demosthenes from printing on his letter heads and catalogues a cut of the "Works" and the river with a palatial steamboat, the "City of Helvertown," sailing majestically down it.

Julius Cæsar McGinnis, the son, was a 'prentice boy in the "Works"; so was I, and so was Shadegg Slate and lots of others not necessary to mention. All the kids around the place had nicknames. Julius Cæsar's was "Slobby"; Shadegg was known as "Rye-Balls, High-Balls, Ricky-Stick Slate," when there was plenty of time, and simply as "Ricky" when time was valuable; mine was "Big-Head-Mulligan," which I mention only to show that the names usually went by contraries, as everybody knows I am extremely modest.

It is hardly necessary to explain that Demosthenes himself was known as "The Old Man."

Ricky's peculiarity was that he *always* had to make more than one piece of everything; that is, he always spoiled the first piece and usually the second and third; thus, one day the kids collected *four* small pieces that Ricky had spoiled while trying to make *one*, and put them in his dinner pail just before quitting time. Nobody ever knew just when and where Ricky discovered the contents of his pail, but they observed the next day, when he spoiled t h r e e larger pieces, that instead of putting them u n d e r the bench where the kids could get at them, he chucked them out of the w i n d o w into the river, but on account of the peculiarity of the river first mentioned the spoiled pieces were plainly visible, and the next day *the foreman brought a pair of rubber boots.*

The Discipline of Demosthenes McGinnis.

The reader will gather from the above that Ricky's mind was likely to be on something else than "learning the trade" most of the time, and of course the something else was usually playing tricks on the other 'prentice boys (and journeymen too, for that matter). So one day he looked out of the window, presumably to see if the steamboat had got by yet, and discovered "Slobby" McGinnis fishing out of the window below, although there was as much chance of Ricky finding the steamboat, as of Slobby finding a fish in *that* river; and it didn't take Ricky very long to find a bucket of dirty water, and pour it down on Slobby's head.

Slobby made a bee-line for the office and told his father what had happened to him, and the old man came out, located the window, went upstairs, and over beside Ricky, who, when he saw the old man, considered that his last hour was come, on account of this and all his former shortcomings.

"Are you the boy that threw the water on Julius?"

"Y-y-yessir," stammered Ricky, knowing denial to be useless.

The old man reached down into his pocket, pulled out a coin, and laid it down on Ricky's lathe and said: "Here's a half dollar for throwing another bucketful of water on him next time you catch him fishing out of the window."

Which goes to show, in my opinion, that the old man had more horse sense than some of his enemies gave him credit for.

HURD & HAGGIN MARINE AND RAILWAY ENGINE.

A new marine and railway gas engine was exhibited at the Motor Boat Show (held in Madison Square Garden the last of February) which attracted much attention on account of its novelty of construction and ingenious features of design. The new engine was designed by Mr. Leon le Pontois, in collaboration with Mr. B. Hurd, and is built by the Hurd & Haggin Engine Co., 316 Hudson Street, New York.

The engine, shown in the accompanying halftone and three line drawings is of the vertical six-cylinder type (38 H.P. at 750 R.P.M.) and is designed for both marine and railway service, the designers having in mind, so far as railway service is concerned, the development of the railway motor car which promises to be an important factor in future steam railway passenger service. The impression made by the engine is that an extraordinary amount of care and thought has been devoted to its design. The compactness, convenience, accessibility and ingenuity of the design are noticeable in every part. In an analysis of the problem of a gasoline engine design of the four-cycle type the engineers have considered that there are five fundamental constituent elements that should be provided for, these being the mechanical construction of the cylinder including the form of the combustion chamber; the location of the valves with relation to the combustion chamber and their mode of operation; the means devised for producing the combustible mixture, and for delivering it uniformly to the cylinders; the means provided for causing the ignition of the explosive mixture at the proper time; the water circulation; and the lubricating system.

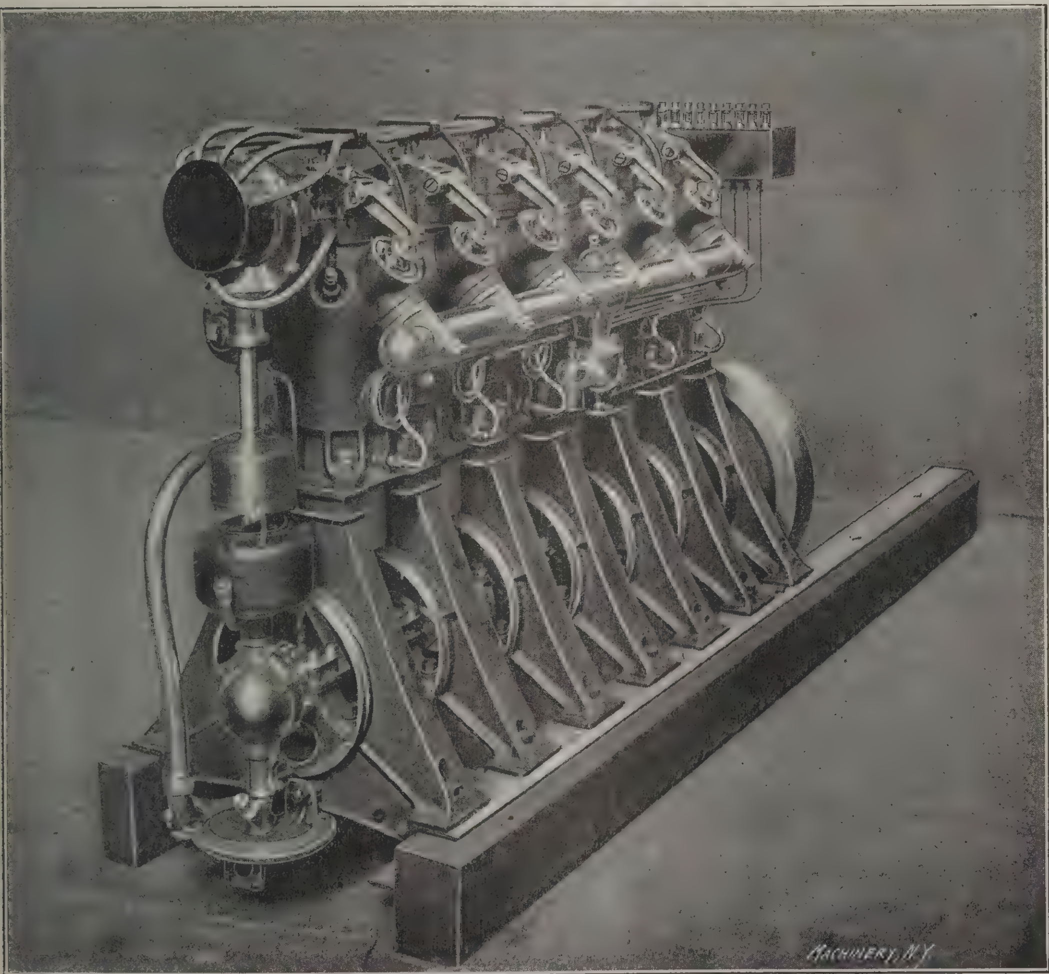


Fig. 1. Hurd & Haggin Marine and Railway Engine.

Mechanical Construction.

The valves, piston and piston ring, connecting-rod, bearings and main bearings of the crankshaft, which are the working parts that need most attention, are made readily accessible. The valves, for example, are located in the top of the combustion chamber at an angle of about 45 degrees which permits of a hemispherical shape to the combustion chamber and gives a minimum of radiating surface for a maximum volume of gases. The valve, the valve seat and spring, are self-contained in a cage which is removed from the cylinder head by unscrewing a locking ring and removing the corresponding rocker arm operating the valve. The removal of the valve cage permits full inspection of the inner walls of the cylinder and combustion chamber. Should there be any carbon deposit resulting from improper lubrication it may be easily removed inasmuch as the inner walls of the cylinder and combustion chamber are machined all over. The inlet and exhaust valves, with their cages, are made interchangeable. The valves are mechanically operated by means of rocker arms oscillated by cams mounted on a camshaft. This camshaft is located on top of the cylinders and is entirely enclosed and runs in a bath of oil. It is operated by a bevel gear drive from the crankshaft through a vertical shaft located on the front end of the engine. This vertical shaft also serves for the sparking apparatus which will be described hereafter. Both pairs of bevel gears are enclosed and run in oil, thus protecting them from grit and excessive wear.

Not the least of the novel features of design is the support for the crankshaft bearing. The struts or columns supporting the cylinders are bored interchangeably and in the openings are seated the bearing brackets. This feature not only provides an ideal means for lining and setting the bearings dead true, but makes the removal of any piston, crankshaft bearing or the crankshaft itself a comparatively simple and easy matter. To remove a piston it is only necessary to detach the crankshaft oil guard, remove the connecting-rod cap, raise the connecting-rod off the crankpin and then withdraw the connecting-rod and piston from the cylinder and out between the struts. Thus the piston and its rings may be examined readily. The reverse operations of restoring the piston to its cylinder are equally as easily effected. The bushings, lined with Fahrig metal, for the crankpin and for the main bearings are also readily removed, and as they are interchangeable, worn bushings may readily be replaced when necessary. By removing all the pistons and the connecting-rods in the manner just described and by removing the main bearing caps the crankshaft may be withdrawn through the circular holes in the columns without disturbing the remainder of the engine. This construction is not found in any other engine.

Fuel Production and Distribution.

The carbureter produces a mixture having a uniform composition under all conditions of throttling. This is effected positively without resorting to the use of auxiliary automatic air valves, by a simple mechanism in which the relative effective areas of the throttle valve and air inlet opening are kept constant. The combustible mixture is distributed to the cylinders by means of diverging nozzles in the manifold so designed that the composition of the mixture entering each cylin-

der is homogeneous regardless of the distance of the cylinder from the source of fuel supply. This construction does away with ungainly shaped manifold pipes ordinarily employed on multiple cylinder gas engines.

Ignition.

Ignition is produced by means of a high tension alternating current generator and a step-up transformer. The primary current is generated in a positively driven alternator, the rotor of which is mounted on the vertical bevel gear shaft. This generator belongs to the inductor type, the rotating element carrying no windings of any kind. The high tension current from the transformer is delivered to the spark plugs of the cylinder by means of a high tension distributor mounted at the top of the bevel gear shaft.

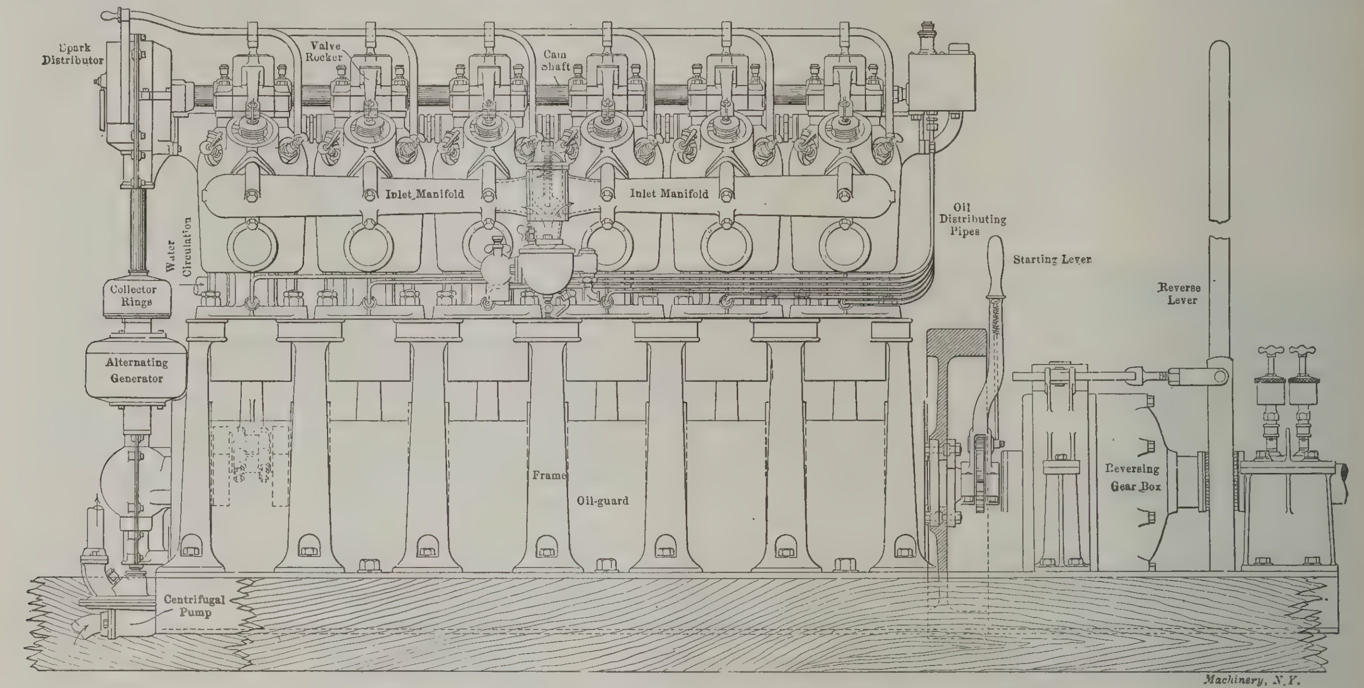


Fig. 2. Side Elevation Hurd & Haggin Six-cylinder Engine, showing the Inlet Manifold.

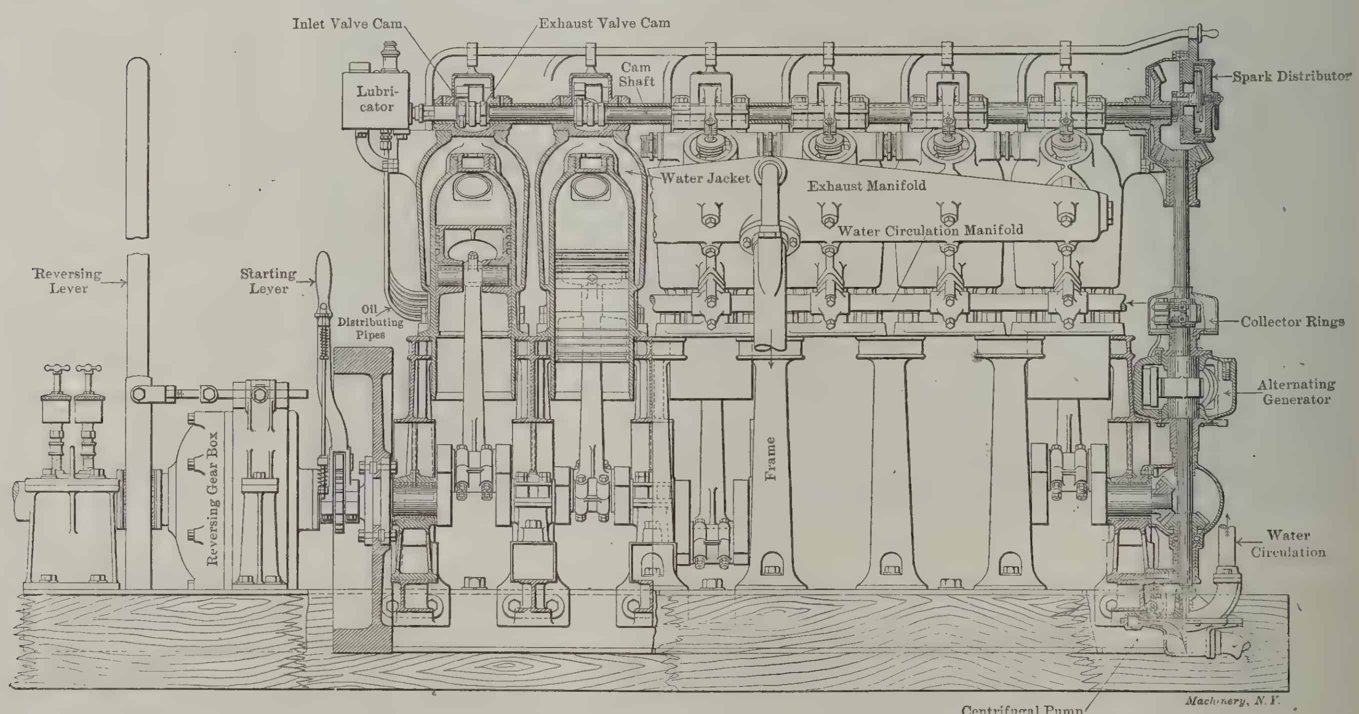


Fig. 3. Side Elevation of Hurd & Haggin Six-cylinder Engine, showing the Exhaust Manifold and Section of Cylinders.

Water Cooling.

An important feature of the design is the adequate means provided for uniformly cooling the cylinder walls and valve chambers. The cooling water is circulated by means of a centrifugal screw pump mounted directly on the lower end of the vertical bevel gear shaft, below the water level, so as to always have the necessary priming. The stream of water issuing from the pump is directed to each cylinder jacket by a manifold. The size of the inlet openings leading from the water manifold to the respective cylinders has been experimentally determined so as to insure an even distribution of water among the cylinders. The cooling water enters the bottom of the water jacket on the exhaust side of the cylinder and leaves it on the same side above the exhaust valve at the top of the cylinder. This circulatory scheme insures proper cooling of the exhaust valve seat. The cooling of the inlet valve seat and of the inlet side of the cylinder is effected by thermo-syphonic action. The water issuing from the upper part of the cylinder jacket, enters the water jacket of the exhaust manifold, circulates around it, and leaves it on the opposite side by an opening at the highest point of the exhaust manifold. This location permits any steam that may be generated, to escape with the water.

Lubrication.

A mechanically-operated multiple forced-feed lubricator is directly driven by the camshaft. Each crankshaft main bearing is connected to the lubricator by a feed pipe, and the ex-

cess oil fed to each bearing works into a grooved oil-ring from which it is guided by centrifugal force into the crankpin bearing. Each cylinder is also connected to the lubricator by an individual feed pipe; the excess oil fed to the cylinder enters the hollow wrist-pin, finding its way to the crankpin bearing through a hole in the connecting-rod. The oil drippings from the bearings are collected in the crankshaft oil guards and are directed by suitable piping to a cistern where the oil is filtered and piped back to the lubricator to be used over again.

These engines are to be built in three cylinder sizes, *viz.*, 4¾ x 5½ inches; 6¾ x 7 inches; 9¾ x 8½ inches, in four-cylinder and six-cylinder units. The rating of the engines is determined by the piston speed in feet per minute, 750 feet per minute being taken as the standard speed. At this speed the power of the 6-cylinder engine illustrated, is 38 H. P.; for 6¾ x 7 inches cylinders 77 H.P.; and for 9¾ x 8½ cylinder 160 H.P. One of the features of design of obvious common sense, but which unfortunately has not been followed in many designs of marine engines, is that the flywheel is placed between the engine and the load where it belongs, thus relieving the crankshaft of unnecessary stresses.

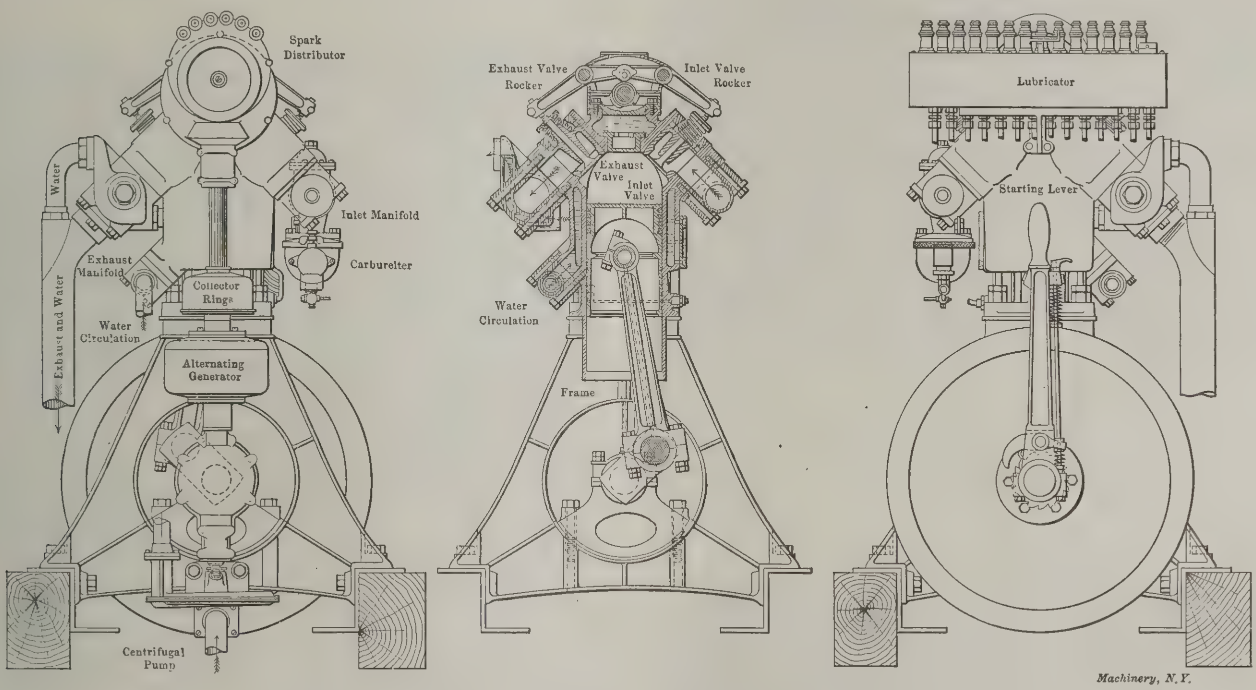


Fig. 4. End Elevations and Section of Hurd & Haggin Six-cylinder Engine

* * *

FAILURE OF WIRE ROPE CONNECTIONS.

The failure of the antenna of the National Signalling Co.'s station at Machihanish, New Brunswick, furnished material for three pages of the January 25, 1907, issue of *Engineering* (London), and so far as is apparent from the description and cuts the failure was due to following a practice in connecting wire rope that was discarded years ago in this country by reputable elevator constructors and others as being unreliable and dangerous. The antenna that failed was 400 feet high and essentially consisted of a steel pipe tower supported by guy ropes attached to the tower at four points in its height and diverging in four directions. The failure was caused by the guy ropes pulling out of their sockets. They were connected in the manner just mentioned as being obsolete and dangerous, that is, by feazing the end of the cable and turning the wire ends outwardly backward on themselves and drawing the feazed end down into the socket, which was then filled with melted zinc. The safe method for connecting wire rope to a socket is quite different. The ends of the wires are untwisted and opened outward and are then turned inwardly backward upon themselves so that the ends of the wires are grouped together in the center, the socket being filled with melted zinc or lead as above. The action of a wire rope and socket connected in this manner is radically different from those connected in the manner followed by the wireless telegraph erectors. In the case where the wires are turned outward there is a continual tendency to slip the ends of the wire backward, as a heavy load is imposed, and there may be a slow creep, eventually causing failure. Where the wires are turned inward there is no tendency for the bent wires to creep, and the enlarged end of the cable wedges tightly in the socket. Although the *Engineer* gives so much space to the failure, showing numbers of photographs of the failed ends, not a word is said of the fundamental cause of the failure.

* * *

THE DIRECTION OF SHOP OPERATIONS.

A correspondent writes: "Much of a foreman's time is taken up in answering foolish and thoughtless questions"—and it is true. The writer then follows with a scolding and asks why, instead of chasing up the foreman and consuming his time by asking some simple or foolish question, they do not use their own "thinkers" and figure out the reason why. It is common in *some* shops for a man to rush off to a foreman the moment he finds the least something that he does not understand. Meanwhile his machine is standing idle, and he loses time in questioning the foreman to get the required information.

No doubt there is a great deal of this foolishness going on, but instead of blaming the workmen alone, may it not be that the foreman is in a large measure responsible for this condition of affairs? Some foremen are so afraid that their prestige will suffer if the men are allowed to exercise initiative and largely go ahead on their own account that they will make a point of finding fault with work that is done without their approval; hence the men soon learn that they must get the foreman's O.K. on any matter over which there might be a difference of opinion. The foreman wishes himself to be felt indispensable and of so much importance that nothing can be done without his direct supervision. In this he makes a bad mistake. He not only loads upon himself an unnecessary burden of responsibility, but weakens his effectiveness as a foreman and tends to make his shop a poorly organized one. The well-organized shop, it has been aptly said, is that which the official head can leave to its own devices for a few days and still feel assured things will run along as smoothly as though he were present. The foreman who is not able to plan ahead and give some workmen directions so that they may be left largely alone for a day or so is wearing himself out in a thankless service.

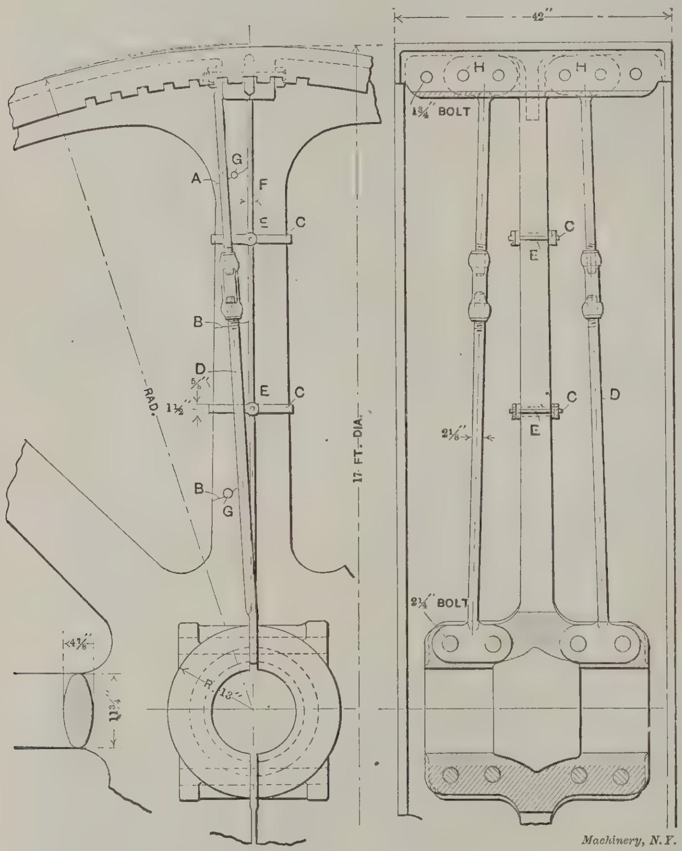
REPAIRING A 17-FOOT FLYWHEEL ARM.

WALTER BIXBY.

While moving one of the halves of a 17-foot flywheel, an arm was cracked at *A* (see cut). A consulting engineer suggested that the best method to repair the break would be to braze the parts together. This plan was tried and proved successful, with the exception, that the rim was distorted about ½ inch, as shown by dot and dash line. In trying to remedy this latter defect, the arm was cracked at *B B*.

The break was finally repaired in this manner: Two wrought iron rods were made 2⅛ inches diameter, as shown at *D*, and two pairs of semi-rings shown at *C*. First, the rings *C* were heated and placed in position and the pins *E* driven in place, the pins being slightly larger than the space *F*. When the rings cooled off, they held the arm firmly in place. The pins *G* were then forced in position to help sustain the arm. The rods *D* were put in place and by means of the turnbuckles, the rim was drawn back to its right position.

We will now see if this manner of mending the arm is strong enough to resist the forces acting on same. The arms



Repairing a 17-foot Flywheel Arm.

have to resist in tension the centrifugal force, and the stresses at the hub due to the bending action considering each arm as a cantilever.

The tensional strength of wrought iron is about three times that of cast iron of the same area. Assume that the areas of the arms are strong enough to resist the centrifugal forces. One half the area of the arm section, considering this an ellipse, is equal to $\frac{\pi \times 11\frac{3}{4} \times 4\frac{7}{8}}{8} = 22.5$ square inches (approximately).

If the sum of the areas of rods is 1/3 that of the arm, the rods resist tension with equal safety as the arm. $1/3 \times 22.5 = 7.5$. Hence the area of one rod ought to be about 3.75 square inches. We used rods 2⅛ inches diameter; their area is 3.55 square inches, which may be considered sufficient.

In calculating the bending action let

M_b = bending moment for one arm,
R = radius of hub = 13 inches,
R_a = radius of flywheel = 102 inches,
A = number of arms = 7,
I = moment of inertia of arm section,
N = number of revolutions per minute = 70,
$H.P.$ = horsepower of engine = 400.

$$\text{Then } M_b = \frac{33{,}000 \times \text{H.P.} \times 12\,(R_a - R)}{2\,\pi \times R_a \times N \times A}$$

or with values inserted

$$M_b = \frac{33{,}000 \times 400 \times 12\,(102 - 13)}{2\,\pi \times 102 \times 70 \times 7} = 45{,}000 \text{ (approximately)}.$$

$$I = \frac{\pi \times (11\frac{3}{4})^3 \times 4\frac{7}{8}}{64} = 385 \text{ (approximately)}.$$

If y equals one-half the width of the arm, then the working fiber stress

$$f = \frac{M_b \times y}{I} = \frac{45{,}000 \times 11\frac{3}{4}}{385 \times 2} = 700 \text{ (nearly)}$$

There is also a shearing action on the bolts *H*, due to the centrifugal force. Assuming the working tensile strength of wrought iron 7,000 pounds per square inch, a rod 2⅛ inches diameter will stand a load of 18,600 pounds. Assuming this load to be applied on bolts *H* in shearing, on one bolt there will be a load of 9,300 pounds. The working shearing strength of wrought iron is 5,000 pounds per square inch, hence, a 1¾-inch bolt will stand 8,750 pounds, nearly the assumed load on one bolt. The factors of safety have been taken high in the above working stresses, because the flywheel is in a paper mill which runs day and night throughout the week.

Another thing to be considered is the effect of the increased weight added to the flywheel acting as a counterweight. It was thought at first that it might affect the engine, but it came exactly opposite the crank pin. The flywheel has been running for three years, and up to the present there has been no trouble experienced or any signs whatever of its giving out.

* * *

THREADING PIPE WITH COLD CHISELS.

Some twenty-five years ago the piping went wrong at an important water station of one of the railroads entering Chicago. The superintendent of the water service, who is responsible for the following account of the incident, got together such men and tools as he could and hurried to the scene. Arriving at the station, he found the four-inch wrought-iron pipe broken squarely off, only two feet of water in the tank, and no means of getting a piece of pipe from any shop, cut to length and threaded, inside of twenty-four hours. Unwilling to interrupt the water supply and determined not to acknowledge defeat until the last resource was tried, he cut a piece of pipe to length with cold-chisels, chalked the unthreaded end, placing it in line, end to end with a threaded old piece of the same size pipe, and with a two-pointed tram, one point engaging the thread of the old pipe, the other scribing on the chalked end of the blank pipe, he followed the thread with one point, always keeping the tram parallel with the axis of the pipe. The path of the right-pitch thread was thus scribed by the tram point on the chalked surface of the blank end of pipe requiring thread. The spiral scribe mark made by the tram was nicked with chisels, deepened and made continuous, until at the end of an hour and a half a good thread was cut, the job put up without a drop of leakage and without interruption of the water service.—*Valve World.*

[This sounds well—but what became of the surplus metal that ordinarily is cut away by the pipe die? The "cold-chisel thread" must have been of greater diameter than the pipe itself unless the pipe were filed away considerably before the thread was "chiseled."—EDITOR.]

* * *

By their overalls ye shall know them.

For the broken teeth of a tap there is no dentist.

The broken-backed monkeywrench had a fool for a user.

A round peg in a square hole—lard oil on the spindle.

Choose your foreman as you would a hammer—weight appropriate to the job.

The common sucker is born, but the shop kind is made by encouragement.

RECENT CHANGES IN MACHINE SHOP, WORCESTER POLYTECHNIC INSTITUTE.

H. P. FAIRFIELD.

The substitution of electric transmission for all departments of the Worcester Polytechnic Institute, upon the installation of the new service plant, gave opportunity for the rearrangement of the equipment in our machine shop, and it is possible that some of the readers may be interested in a few photographs showing the present driving arrangement.

Because of the first cost and necessity of making use of the original machines, no attempt has been made to install individual motors, group driving being used instead. When the use of individual motors was under consideration, the builders of machine tools consulted, and the users as well, were unanimous in condemning the use of individual motors under 2 H.P.

In considering the group-drive plan, the character of the work done in our shops was taken into account, and as this is what may be termed "light machine tool work," the groups

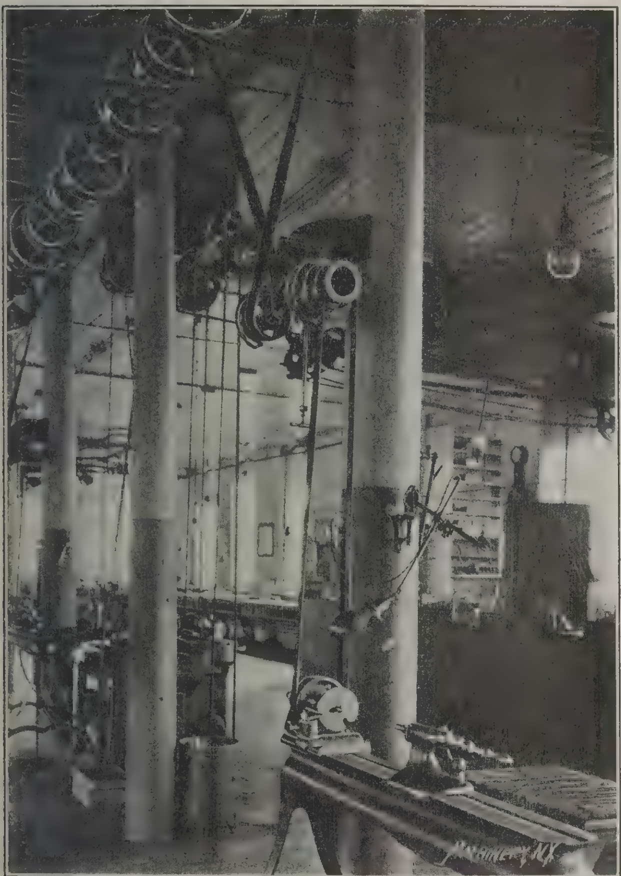


Fig. 1. Speed Lathes Located directly beneath Lineshaft.

have been made in *number* and *size* of machines, and the motor is therefore of relatively small power. Two sizes of groups obtain. The motors driving them, rated as 5 H.P. and 10 H.P., are of the two-phase A. C. type, very compact and easily installed. The major part of the groups is driven by 5-H.P. motors, and in most cases the present installation of these merely meant, first, a decision upon their location; second, the size of group to drive, and the cutting of former line-shafting into sections to suit. All groups as now arranged are really double groups, planned with sufficient vacant floor space to permit additions of equipment. When any motor becomes overloaded by new acquisitions of machinery, a second motor will be installed, and two groups made of what was formerly one. In this manner, instead of growing new groups as the equipment is increased, there is an opportunity given to keep each group up to date by additions of new and strictly modern machinery. The vacant floor space necessary to carry out this idea is gained by a more compact and scientific arrangement of the former equipment. One instance of this utilization of floor space is shown in Fig. 1, where the speed lathes are placed directly under the line shafting. An engine

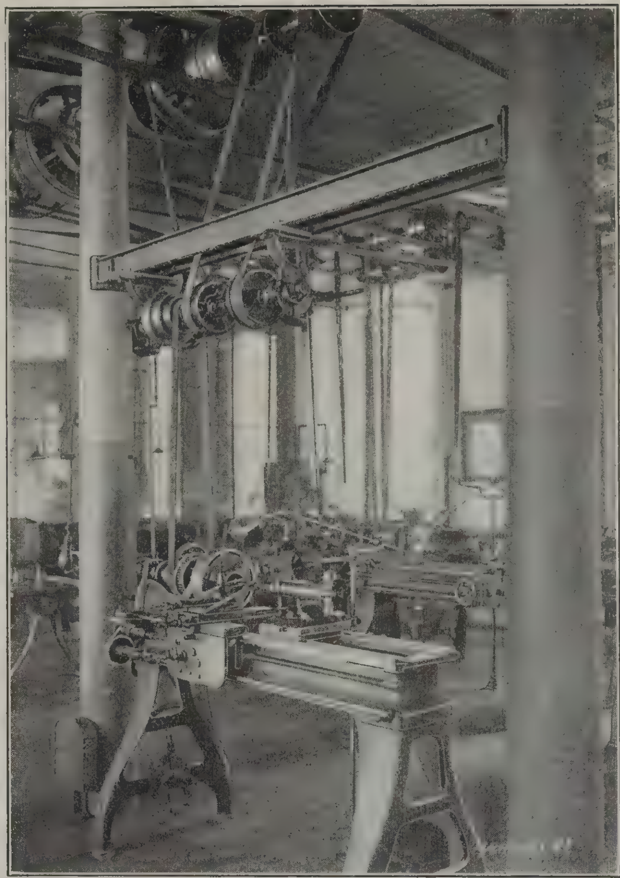


Fig. 2. Engine Lathe beneath Lineshaft and driven by Short Belt from Countershaft.

lathe is also arranged, by way of experiment, beneath the line shafting, as shown in Fig. 2, and the shortening of the vertical driving belt does not appear to lessen its pulling power appreciably. The motors being hung from the ceiling, as shown in Fig. 3, a good opportunity was given to place them so that a

Fig. 3. General View of one Section showing Motor, System of Electric Lighting, Etc.

proper length of belt could be obtained, and also to have the lower side of the belt drive. The motor that drives group No. 5, which is a planer group, has an especially long belt to equalize shock due to reversal of the pulleys on the machines.

The groups are divided into three sorts: lathe groups, mixed groups, and planer groups. The mixed group is the most common, and consists in every case of several lathes, and beside this, one or more machines of an essentially different character. Group No. 2, for example, consists of six 14-inch engine lathes, two 9-inch speed lathes, small drill press, 15-inch shaper, universal milling machine, 24-inch planer, and a globe tool grinder. Group No. 5 consists of a 30-inch by 10-foot and a 36-inch by 14-foot planer. No. 2 and No. 5 thus represent the extremes in the present grouping scheme. The question of lighting the several machines was solved, as shown in the views, particularly Figs. 3 and 4, by putting the wires beneath the floor, and thus avoiding the tangle of belts, wires, and overhead fixtures present in many shops. The convenience with which these lights may be handled is such that it is in general favor with those using the machines. An increase in the speed of the line shafting from 150 R.P.M. to about 200 R.P.M. was also made to meet the demands at the machines due to the use of the high-speed steels.

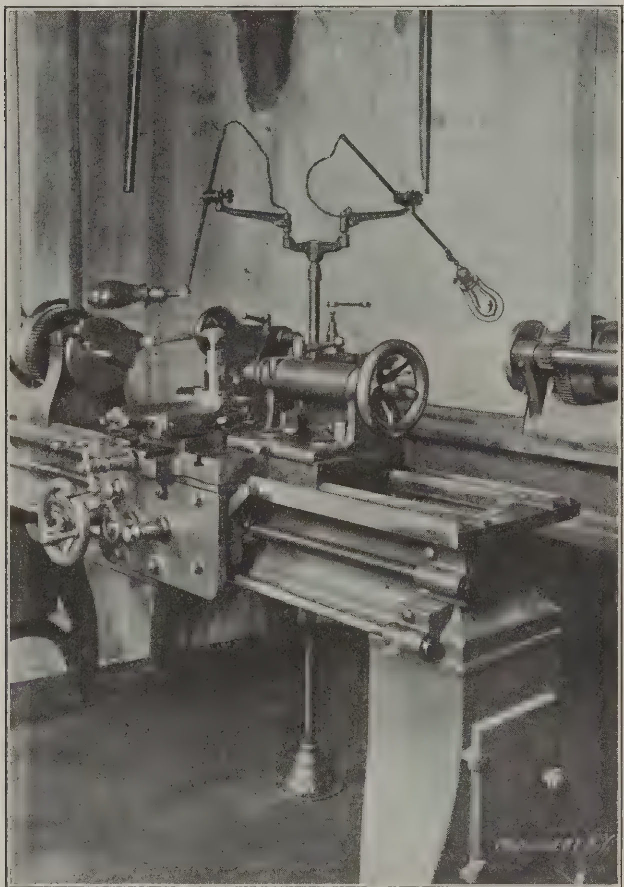


Fig. 4. Engine Lathe with Electric Light Holder in Rear.

Enlarged photographs of machines, suitably framed to hang upon our shop walls, were solicited from about twenty-five representative firms, and in only one instance did we fail to receive a favorable reply. Many of these pictures have already been received and hung, Fig. 3 showing a small portion of the total number. The effect is pleasing and valuable, as it shows what is being done in machinery designing.

A demonstration room is also being slowly equipped with the latest time and cost-keeping devices, such as time clocks, time stamps, and methods of keeping track of stock. Beside this, many special tools are placed on exhibition. As this entire equipment is to be in the nature of a loan or gift, it, like the pictures, must come by solicitation.

Additions of new machine tools are being made from time to time and in every way possible the shop is to be kept up to date. The students are thus able to know something of the conditions under which the manufacturing manager exists, although no attempt is made to make the shop a factory.

SOME GOOD THINGS NOT IN COMMON USE.

E. R. PLAISTED.

I do not want to be accused of re-writing ancient history, but what else is to be done when those fellows continue to bob up with new recipes for fluid to write white on blueprints? To my personal knowledge there have been on the market for nearly twenty years several preparations that are perfectly satisfactory for this purpose, and as much to be preferred to any of the home-made dopes of saleratus or lime as Higgins' or Post's inks are preferable to the sort we used to grind off the end of a stick in the "good old times."

The kind I use is called "crystalline" ink; it writes as clear white as the paper itself, never discolors with age, nor does it rot the paper. I have never been able to detect traces of corrosion on the pens in consequence of using it, though I handle it with the care I would give to any such preparation whose composition I am ignorant of. These fluids are a colorless acid, and some bear the poison label of skull and crossbones, though the kind I use does not. They can be had in colors as well as in the clear white, and sell for 15 cents a bottle at all dealers in draftsman's supplies. Quite too cheap to do without.

I believe at one time someone wrote a short article telling what the name of this acid is, but I cannot recall it, and the local druggists do not seem to be able to duplicate it from their stock. But as it is put up in such convenient form by the supply houses and sold at such a low price I do not see how any draftsman who knows of it can afford to worry along with solutions of lime, soda, ammonia, chinese white, etc., etc.

Another good thing that the dealers do *not* sell is the cross section paper made by the J. C. Hall Company, Providence, R. I. I found the Brown & Sharpe drafting force using large quantities of it, and they gave me the address of the makers. My own experience has only confirmed the good opinion their high endorsement of it gave me.

It comes in sheets 18 x 25 inches, ruled in eighths, with a blank white margin of some ¾ inch around the edges. The lines at halves and inches are a trifle heavier than the eighths, and it can be had in tenths also if one desires that spacing. Also it is supplied in two grades of stock, one a fine bond and the other a smoother and cheaper paper, though amply good enough for all common shop work. Both yield a fair blueprint direct from the drawing.

The Hall Company also put out two sizes of pads of cross section paper, one 5 x 7 ruled in sixteenths to 4 x 6, the other 7 x 9 with same ruling and width of margin. I find both very handy, and also keep a good stock of the common cross section paper ruled all over in quarter inches. This I have in pads of two sizes, one being "typewriter" size for use in making sketches that are to be copied in letter books, and sent with letters. The smaller size is very handy for general rough sketching and figuring, and so cheap that I do not keep any other sketch pads in the drafting room. I once read a kick from a fellow who didn't think cross section paper was any good for laying out gear teeth on, and I presume he was right about it, but for such work as it is adapted to, and that is the large majority of sketching jobs, it is a great saving of time. For rushing a hurry job into the shop I do not know of anything to compare with it.

I fully endorse that item about keeping a piece of blotting paper hanging handy to the drafting table, and a patent spring clothes-pin makes a good holder for it, as it can be snatched in an instant when the moment of need arrives. This is sure to come sooner or later, and no matter how many pieces are lying around loose none ever happens to be within reach just then.

Still another good thing that I have not been able to find in catalogues of draftsmen's supplies is a "pick-ed" stick for writing and lettering on shop drawings. So primitive an affair may not seem worth carrying in stock, but there are sticks and sticks, and even back here in the woods I had considerable difficulty in getting just what I wanted. It is made from boxwood, whittled and sandpapered to a sharp point, four sided, and though it does not hold its point like a metallic tool it is better than anything else I ever tried for lettering and dimensioning on common shop drawings. When I first

began drafting I put in my dimensions with common steel pens, some of which were sold as "lettering pens" but were actually no better than the common kind. All gave a shaded line, and to my mind this is a nuisance on a working drawing. Then I tried the stylo and the glass pens used for marking linen. These gave lines of even width and weight but were unsatisfactory in other ways. Finally I tried a "wedge screw" ruling pen which I re-ground in such a way that the blades would not catch and splutter, no matter what angle it might be held at. For fine lettering and dimensioning I have never found anything better, but I still have to grind them myself. Even the best instrument repairers do not get the blades dressed to the required smoothness, for a pen which will work perfectly when used with a ruler may be a total failure at this business. The wedge screw pen is adjusted from the end of the handle and has no screw in the blades to get in the way when writing.

* * *

PHOTOGRAPHING DRAWINGS.

Blueprints made from drawings on a greatly reduced scale are convenient and oftentimes they will serve the purpose precisely as well as the large sheets commonly used. The *Street Railway Journal* calls attention to the desirability of providing small blueprints for field work in preference to large prints which can only be referred to with great inconvenience, especially in windy weather. While the conditions in shop practice are not the same as in field work, it nevertheless is true that a large blueprint is often a troublesome affair to refer to in the shop unless mounted, and if it is not to be used continuously this labor is generally avoided. Oftentimes a blueprint is of so simple a character that there is little good in its being made to a large scale. The large shop print is a relic of the days when all drawings were made without figures and were scaled for all required dimensions. Of course, a drawing must be made to such a scale as will permit the draftsman to correctly and plainly show the details and dimensions, but an inked drawing can be photographed clearly to a greatly reduced size. A negative 6½ x 8½, properly exposed will print drawings with surprising sharpness and clearness on gaslight paper, even though of a complicated design. These might not do for shop work in some cases, but for general reference and over-all dimensions such miniature prints are far preferable to the ungainly drawings commonly sent into the shop. The expense of making photographic reproductions, and the trouble and time required, operate against such practice being followed in the smaller shops, but in larger shops it is a practice to be highly commended and is one that is finding favor.

Interior of New Edgwick Works, Alfred Herbert, Ltd., Coventry, England.

THE EDGWICK WORKS OF ALFRED HERBERT, LIMITED.

The accompanying view showing the interior of the new Edgwick works of Alfred Herbert, Ltd., Coventry, England, was received too late for publication in the March issue in connection with the article there appearing. This view gives a good idea of the excellence of interior lighting, and shows the column construction alluded to in the previous article more clearly than did the view given; it also shows the method of hanging the countershafts. In this connection an error should be corrected in regard to the size of the plant. The present size is 100 x 240 feet, and it was stated in the previous article that the plant provided for extending to 240 x 400 feet, all under one roof. What the plans *do* provide for is an extension to 300 x 400 feet; not only are the bays to be lengthened to 400 feet, but two additional bays are provided for. Consequently the power plant is only one-fifth of its destined ultimate size, instead of one-fourth, as stated.

MEASURING WIDTH OF FLAT ON U. S. STANDARD THREAD TOOLS.

ERIK OBERG.

When making U. S. standard threading tools it is comparatively easy to arrange for gaging the angle, but the measuring of the width of the flat is a more difficult task, if by measuring we understand the process of making sure that the flat is fully correct, and not merely comparing the thread tool we make with a manufactured thread gage, which is a very uncertain test for accurate work. The common method is a "cut and try" scheme, first cutting a thread on a cylindrical piece with the tool supposed to be approximately correct, and afterward using the same thread tool with which this thread was cut to plane a groove in a flat piece of steel. The groove in the flat piece of steel is then a duplicate of the thread previously cut and should also be an exact duplicate of the section $GACF$ of the thread cut on the cylindrical piece (see Fig. 1). When testing, if the groove proves to be an exact duplicate of the thread form, the flat evidently is correct, inasmuch as the flat at the bottom and at the top of the thread are alike, it being supposed that the angle was previously tested and found correct. However, if the groove in the flat steel piece does not exactly fit the section of the thread on the cylindrical piece, it is necessary to grind the tool again and make another trial, continuing this until a tool with a correct flat is produced. The ideal method would be if the flat could be directly measured by micrometers, in which case there would be no uncertainties, and a correct tool could be produced more directly and with less work. It is, of course, not possible to measure with micrometers the distance AC in Fig. 1, as such a measurement would be at best uncertain for large pitches, and absolutely impossible to make on smaller ones, even when using an eyeglass. If, however, the vertical distance BD from the top of the thread down to the flat can be measured, the width of the flat is easily figured, as for a U. S. standard thread,

$$AC = 2BD \times \tan 30 \text{ deg.}$$

This distance can, of course, not be measured with ordinary micrometers, but a micrometer can be simply designed which may be used for obtaining this distance. Such a micrometer is shown in Fig. 3. If it were only a case of measuring a threading tool without clearance the angle CBD in Fig. 3 would simply need to be 60 degrees, and the micrometer so graduated that the reading would be zero when the face A of the measuring screw was exactly in line with the point B of the angle CBD. When wanting to measure the width of the flat of a threading tool, the tool would be placed in the angular space provided for it and the micrometer adjusted until the face of the measuring screw would touch the flat. The reading then should be multiplied by two times the tangent for 30 degrees or 1.155.

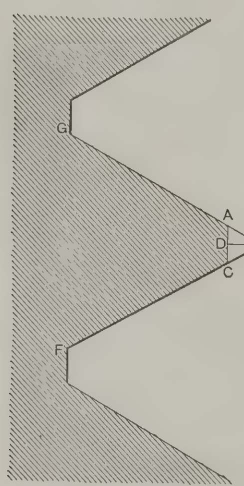


Fig. 1. Section of U. S. Standard Thread.

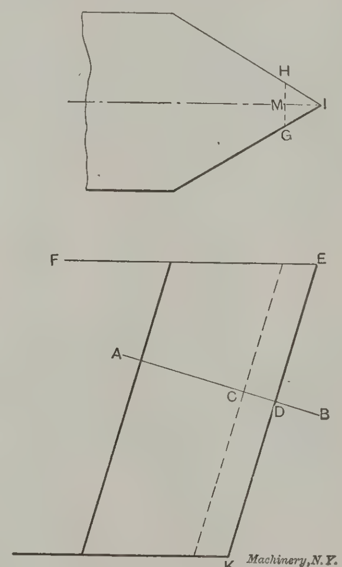


Fig. 2. U. S. Standard Thread Tool before Grinding Flat.

As the threading tool is provided with clearance, the case, however, is not quite so simple, but still presents no actual difficulties. Referring to Fig. 2, where a threading tool is provided with 15 degrees clearance, it is evident that the measurement taken by the micrometer will have to be along the line CD in a plane AB at right angles to the line EK. The length of the line CD is equal to MI multiplied by cosine of 15 degrees, or, reversing the expression,

$$MI = \frac{CD}{\cos 15 \text{ deg.}}$$

The width of the flat HG again is equal to $2 \times MI \times$ tangent for 30 degrees. Thus:

$$HG = 2 \times \frac{CD}{\cos 15 \text{ deg.}} \times \tan 30 \text{ deg.}$$

or in other words, the width of the flat of the threading tool equals 2 times the distance measured by the micrometers in the plane AB divided by cosine of 15 degrees, the quotient multiplied by the tangent for 30 degrees. We naturally would reverse the formula when wanting to produce a threading tool for a given pitch, the width of the flat HG being then given from the beginning and the distance we require to know being CD. Knowing this distance, we can grind down the sharp V-tool until we read off on the micrometer the required figure for CD. The formula for determining CD is:

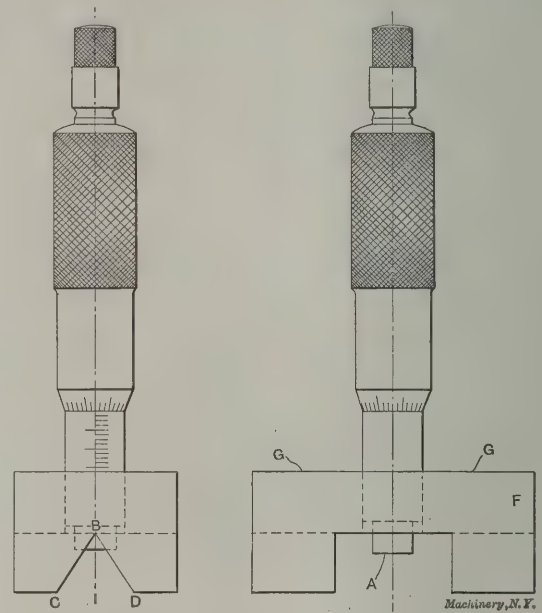


Fig. 3. Micrometer for Determining the Flat of U. S. Standard Thread Tools.

$$CD = \frac{HG}{2} \times \cot 30 \text{ deg.} \times \cos 15 \text{ deg.}$$

For U. S. standard thread,

$$HG = \tfrac{1}{8} \times \frac{1}{\text{No. of threads per in.}}$$

If N denotes the number of threads per inch, the formula may be written:

$$CD = \frac{\cot 30 \text{ deg.} \times \cos 15 \text{ deg.}}{16\,N}$$

In the table appended the values of CD are given for a number of United States standard pitches when the clearance angle of the tool is 15 degrees.

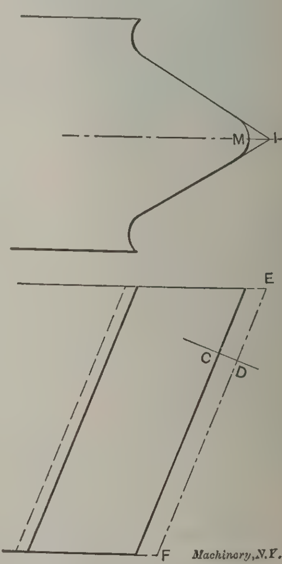


Fig. 4. Whitworth Standard Thread Tool.

Referring now to Fig. 3, the micrometer consists of an ordinary micrometer head fitted into a block F. This block is provided with an angular groove CBD to receive the tool. The angle to which to plane this block equals 61 degrees 44 minutes, which is the angle between the faces IH and IG in Fig. 2, measured in the plane AB. In the center of the block, where the micrometer head is attached, part of the block is

cut away, leaving a free view of the tool and the face of the measuring screw when the former is placed in position for measuring. The micrometer head used may either be an ordinary one with regular graduations, in which case the reading of the micrometer must be carefully noted when the face A of the screw is in line with the point B of the angular groove, but it is still better, if one wants to go to the expense, to make the head with a special graduation having the zero mark where the face and point of the angle coincide. In this latter case the graduations would evidently be made in a

TABLE I. MICROMETER READINGS FOR MEASURING THE FLAT OF U. S. STANDARD THREAD TOOLS.

Clearance Angle 15 Degrees.

No. of Threads per inch.	Micrometer Reading.	No. of Threads per inch.	Micrometer Reading.	No. of Threads per inch.	Micrometer Reading.
3	0.0349	13	0.0080	40	0.0026
3¼	0.0322	14	0.0074	42	0.0025
3½	0.0299	16	0.0066	44	0.0024
4	0.0262	18	0.0058	46	0.0023
4½	0.0233	20	0.0052	48	0.0022
5	0.0210	22	0.0047	50	0.0021
5½	0.0190	24	0.0043	52	0.0020
6	0.0174	26	0.0041	56	0.0018
7	0.0150	28	0.0038	60	0.0017
8	0.0131	30	0.0035	64	0.0016
9	0.0116	32	0.0033	68	0.0015
10	0.0104	34	0.0031	72	0.0015
11	0.0095	36	0.0029	76	0.0014
12	0.0087	38	0.0027	80	0.0014

TABLE II. MICROMETER READINGS FOR TESTING WHITWORTH THREAD TOOLS.

Clearance Angle 15 Degrees.

No. of Threads per inch.	Micrometer Reading.	No. of Threads per inch.	Micrometer Reading.	No. of Threads per inch.	Micrometer Reading.
3	0.0515	8	0.0193	20	0.0077
3¼	0.0477	9	0.0172	22	0.0071
3½	0.0442	10	0.0155	24	0.0065
4	0.0386	11	0.0141	26	0.0060
4½	0.0344	12	0.0128	28	0.0055
5	0.0310	13	0.0119	30	0.0051
5½	0.0281	14	0.0110	32	0.0048
6	0.0258	16	0.0097	36	0.0043
7	0.0221	18	0.0086	40	0.0039

TABLE III. MICROMETER READING FOR TESTING BRITISH ASSOCIATION STANDARD THREAD TOOLS.

Clearance Angle 15 Degrees.

British Asso. No.	Micrometer Reading.	British Asso. No.	Micrometer Reading.	British Asso. No.	Micrometer Reading.
0	0.0102	6	0.0054	14	0.0023
1	0.0092	7	0.0049	16	0.0019
2	0 0082	8	0.0043	18	0.0015
3	0 0074	9	0.0040	20	0.0013
4	0.0068	10	0.0036	22	0.0010
5	0.0060	12	0.0029	24	0.0008

direction opposite to the one on an ordinary micrometer barrel. In the former case it would be necessary to subtract the measured reading from the reading when A and B coincide in order to obtain the length of the line CD in Fig. 2. To facilitate the holding of the tool when measuring, it is advisable to knurl it on the top at G.

This manner of measuring can be conveniently employed when testing or inspecting tools with round points like the tools used for originating the thread tools used to cut the Whitworth or the British Association Standard thread. In this case, the length of a line CD from the point I to the highest part M of the radius measured in a plane at right angles to EF as shown in Fig. 4, must be determined. The angle CBD (Fig. 3) of the block must of course be made according to the angle of the thread which is measured. If the angle of the thread is v, the angle CBD is determined from the formula

$$\tan \frac{CBD}{2} = \frac{\tan \frac{v}{2}}{\cos 15 \text{ deg.}},$$

provided that the clearance angle is 15 degrees. The values for the length of the line CD measured on a tool with 15 degrees clearance angle are given in Table II. for the Whitworth standard thread and in Table III. for the most common pitches of the British Association standard thread.

* * *

THE SHOP DIRECTORY.

The shop directory is a new idea which is being introduced into the highly organized systems of modern manufacturing establishments. In practice it constitutes a not unimportant adjunct to industrial management, much more important than it may seem at first thought. To have the place of residence of every employe ready at hand must often prove a convenience. Occasion may arise when it must mean much more than mere convenience. In case of fire certain men might be needed immediately to furnish necessary information concerning the works. It may be the electrician, whose services are required to do emergency work. A man may not report for work and it may be necessary to communicate with him. In giving out overtime work men may be picked more judiciously, so that a minimum amount of hardship may result. There are occasions when the addresses of the men permit of using the mails for distributing literature or other mail matter.

The record goes further than mere residence. Something of the man's history is kept, whether he is married or single, and if he has children, information which is usually sought when it becomes necessary to reduce a working force. It is important to have a record of each man's usefulness as a workman, including the particular line of work at which he is employed, and also any other branch of work in which he has had experience. Where no such record exists—and few works have it—information concerning the workmen is frequently sought for various reasons and is gathered piecemeal, generally at the cost of some time and trouble. Occasionally it cannot be obtained. In large establishments, employing many hands, there is no one with even general information concerning all the working force. The superintendent cannot keep track of more than the older employes; his information is usually only that which comes with long contact with his men in the routine of his duties. Each foreman knows his own men pretty well if he has been long enough in his position, but there are always new men of whom no one has much knowledge. When a foreman leaves, his successor has to learn the force all over again. It is safe to assume that few foremen, in large or small establishments, could give the house address of a quarter of their men. The information needed for the shop directory is not difficult to obtain, as blanks distributed for the men to fill out will gather the necessary details, and as new men are employed each can fill out the same blank, and its contents be added to the general record.—*Open Shop.*

* * *

It is not unusual that our European friends form exaggerated opinions regarding the prosperity of this country, and the wages paid to all classes of labor. One of our English contemporaries has received reports of "abnormal" prosperity in the United States, and we do not censure the writer for using the word abnormal in view of the fact that "it is said that skilled workmen earn from 8£ to 12£ per week." From now on, let us not wonder why there come nearly a million immigrants to our shores yearly. The exaggerated prosperity claims of our own press have evidently been taken for plain truth on the other side; hence the story of our "abnormal" prosperity.

* * *

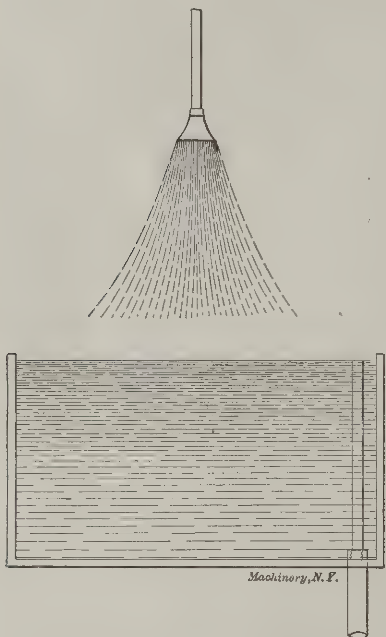
That the automobile has proven itself to be a commercial vehicle when put to use in a manner calculated to show results, and not only for advertising or similar purposes, is amply in evidence in the case of the London Motor Omnibus Co., which reports a gross revenue of $400,000 in a year and has just paid 10 per cent dividend. That, however, the automobile is as yet a great source of trouble is also in evidence, as we understand that out of 600 cabs used in passenger transportation in London on the average 200 are constantly in the repair shops.

A CASEHARDENING INCIDENT.

E. R. MARKHAM.

I was called to a shop not long ago to tell the owners, if possible, why they could not harden certain articles which were heated in a crucible containing cyanide of potassium. They had been hardening similar pieces made from the same grade of low-carbon steel for a long period, and had always obtained uniform results heretofore. In order that they might get the same results uniformly without frequent experiments, steel of a certain analysis had always been ordered, and from the same mill. To further safeguard against trouble it was the custom to make an analysis from drillings taken from several bars selected here and there from each shipment received. As the lot of bars from which the pieces being treated were made, did not show any material difference from those received before, the shop men were in a quandary to know why the work would not caseharden satisfactorily, inasmuch as it was treated exactly as previous lots had been.

The usual custom was followed in the use of cyanide; it was melted in a cast iron pot and heated until it was red hot. The pieces to be hardened were made from 0.30 carbon open-hearth steel, and were suspended in the red-hot cyanide and allowed to remain about three minutes. Then they were removed and plunged in a bath of water. But these pieces under consideration would not harden; they were found to be considerably stiffer than before given the treatment, but the surface was not hard and as this was a necessary requirement we started to investigate the matter.



Spray of Water for Producing Beautiful Effects on Casehardened Work.

I found upon inquiry that a new cast-iron crucible was being used, as the old one had developed a crack, and the hardeners thought that so long as the contents of the old crucible had been in use for a considerable time they would melt up a new lot of cyanide. After a few preliminary skirmishes which amounted to nothing in particular, we heated several of the pieces in an open fire and applied some of the new cyanide to them; then after reheating to a good bright red they were plunged into water. When tested with a file the pieces showed soft and, in fact, appeared to be in about the same condition as those heated in the crucible. Then several more pieces were heated and some of the old cyanide that remained in the old crucible, was applied and the pieces dipped as before. These showed a hard surface, thus proving that the new cyanide of potassium was at fault.

An examination of the cans in which the cyanide came showed it to be "50 per cent fused" cyanide, a low grade cyanide sold in cake form. Now, I had used fused cyanide for years in the treatment of gun frames which we wished to have the appearance of having been casehardened for color, but which at the same time were desired to be left in the soft state, and I then knew just what the trouble was. To make a long story short, 50 per cent fused cyanide does not carbonize the surface of iron, but if used in a certain manner it will give it the beautiful colors to be seen on the surfaces of pieces that are actually casehardened for color.

Perhaps it will not be out of place to give in brief the process employed when treating gun frames and similar pieces for imitation casehardening, the object being to get the characteristic coloring. The pieces are first polished nicely and then cleaned; they are then suspended by wires in a crucible of red-hot cyanide of potassium, the same as though a hardened surface were to be produced. In this case, however, the commercial article is not used, but 50 per cent fused cyanide is used instead. When the pieces have been in the fused cyanide for the desired length of time they are removed one at a time and dipped in the bath. This should be running water. If it be desired to produce the elegant vine-like appearance often seen on gun frames, the water should be delivered to the bath from an overhead pipe, as shown in the cut; the end of the pipe is fixed so as to spray the water, and the frame when taken from the cyanide is first passed through the spray and then immersed in the bath. The temperature of the cyanide has a great deal to do with the appearance of the work; if it be too hot the colors will not be as beautiful as though the work was heated only to a fairly low red heat.

If hardened surfaces are desired, the regular cyanide of potassium, carefully kept from the influence of the air, should be used; the depth of the hardened surface may be gaged by the time the pieces are left in the cyanide. At times it may be desired to give tool steel tool shanks or similar pieces the beautiful surface first described and still not leave them as hard as when taken from the bath. This may be accomplished by treating them as above described and then placing them in a kettle of oil over the tempering furnace and drawing to the desired temper. The heat should be accurately gaged by means of a high-temperature thermometer. It will be necessary to allow the piece to remain in oil until it is cooled off, or at least until it has cooled below 400 degrees F. Unless this is done the colors will change to temper colors. This effect is caused by the thin film of oxide which is always noticeable when polished surfaces of steel or iron are heated to a temperature above that mentioned. This fact is taken advantage of, of course, to denote the amount of heat absorbed by the pieces of steel when drawing the temper of hardened pieces.

* * *

At a time when it has been urged that rates for second-class postal matter should be increased in order to enable the postal department to be self-supporting, it is appropriate to call attention to the fact that undoubtedly the postal department would show a net profit instead of a deficit if it were not for the exorbitant railway rates that the postal department is forced to pay to the railroads for transportation of the mails. According to the *Medical World*, Prof. H. C. Adams, the railway expert for the United States Interstate Commerce Commission, has shown that the railroad receipts for 100 pounds of freight from New York to Chicago are on an average 75 cents, for express $1.25 and for mail $3.56; from New York to San Francisco the amounts would be $3 for freight, $6.75 for express and $13.28 for mail per hundred pounds. It appears that the railroads receive, on the average, for express 50 to 100 per cent more than for first-class freight, and for mail 100 to 300 per cent more than for express.

The express companies do not pay rentals for use of express cars. It does not seem reasonable that the government should pay rental for postal cars; consequently there is over five and a half million dollars' expenditure for which there does not seem to be any sufficient reason. Furthermore, the remaining $39,000,000 paid for mail transportation is paid on the basis of a rate of two or three times as great as that received by the railroads for the carriage of express. Prof. Adams estimates that the railroads receive for carrying the mails 12.56 cents per ton-mile; for carrying express they generally get from three to six cents per ton-mile; for carrying excess baggage, five to six cents per ton-mile; for commutation passengers, six cents per ton-mile; and for carrying the average of all freight, 0.78 cent per ton-mile. The mail is a sure, steady traffic, homogeneous, easily handled and does not require such expense as does baggage for storage, loading and unloading, etc., there being practically no cost but the cost of haulage. How inconsistent, then, that the government should pay more for the carrying of mails than is paid for any other similar service. It is unpleasant to use the correct name for this practice of the railroads to exact payment out of all proportion to the service rendered, and we will hope that the future will place our postal service on a more equitable basis.

ITEMS OF MECHANICAL INTEREST.

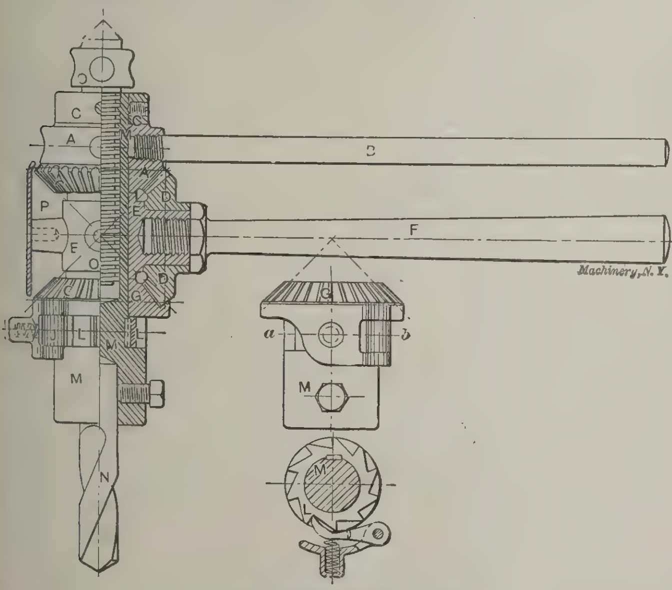
AN ABSURD GERMAN TOOL ADVERTISEMENT.

Successful advertising is said to be an art, but if this weird design, taken from a German engineering publication, is an example of the successful kind it would seem that sometimes it were closely allied to "black art." It may be merely the result of a vivid imagination overstimulated by beer and limburger, but whatever the cause, the "adsmith" has a good deal to answer for. Is it advertising or is it caricature to represent His Satanic Majesty's minions sharpening their pitchforks (or are they ice-picks) on a Bonner Fraeserfabrik milling cutter? A devil's imp might be able to hold a pitchfork against a milling cutter so firmly that the metal would be sliced off in large shavings to the accompaniment of fireworks, but *we* doubt it. The incongruity and absurdity of advertising machinery and tools in such a manner nowadays are too obvious for further comment.

German Tool Advertisement.

IMPROVED RATCHET DRILL.

The accompanying cut from the *Mechanical World* shows a variable speed ratchet drill made by J. Leslie Watson, Duke Street, Arbroath, England. The drill *N* is carried by a spindle *M* upon which the bevel gear *G* is mounted. This gear turns loosely on the spindle and has a projection, as shown in the detailed view. To this projection is fastened a pawl engaging with a ratchet *L* for rotating the drill. Intermediate gear *D* is carried by a sleeve *E*, into which latter the handle *F* is screwed. The upper gear *A* is, like gear *G*, free to rotate on the spindle, and is furnished with a handle *B*. The collar *C* keeps the three gears in mesh with one another, and a casing *P* is provided, which forms a guard around the gear teeth. The drill is fed in the usual way by the feed screw *O*.

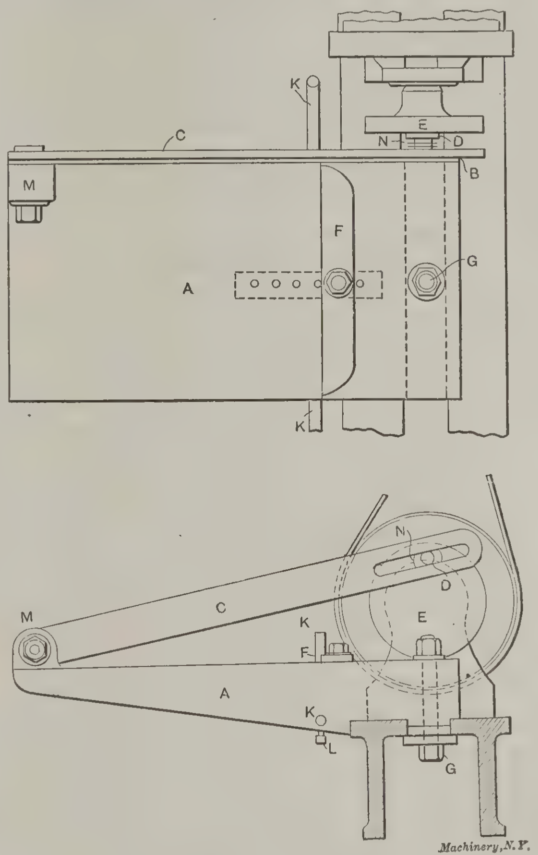


Variable Speed Ratchet Drill.

To use the brace in the ordinary manner, both handles are grasped with one hand and operated together. If *B* is turned to the left-hand side of the device and held while *F* is pulled toward the operator, the drill will turn at twice the ordinary speed; while if, with the handles still on opposite sides, both are drawn toward the operator, the speed of cutting will be three times as great as that obtained by directly operating the brace. The maker claims that with this brace he can drill, without extra exertion, a 9/16-inch hole through 1 inch of cast-iron in six minutes, or put the same drill through a ¾-inch steel plate in nine minutes. This he claims is 50 per cent quicker than by the ordinary type of ratchet drill.

SHEARING ATTACHMENT FOR THE LATHE.

The accompanying illustrations, taken from the *Practical Engineer*, shows a rig developed by an amateur for shearing sheets on the lathe. It consists of a casting *A* bolted to the lathe bed and having a boss at the outer end on which is pivoted the knife or shear *C*. The shear side of the casting is faced with a plain steel strip about ¼ x 2 inches section, held by fillister-head screws, and set at a slight angle from the vertical so as to provide clearance without the necessity of grinding to shape. The shear blade *C*, ½ x 2 inches, is slotted for a crankpin *D*. This crankpin is made in the form of a headless shouldered stud having a screw at the face-plate end which is inserted through a slot in the faceplate and held by a nut on the back side. A coil spring *N* between the shear blade and stud collar keeps the blade in close contact with the opposite cutting edge. The action of the shear is obvious and needs no further explanation.



Shearing Attachment for the Lathe.

* * *

There is, at the present time, a movement abroad in England to prevent any one from securing and holding a patent in that country unless it be worked in the United Kingdom. The president of the Board of Trade in London, in reply to a petition presenting the grievances of British manufacturers in regard to the non-working of patents granted to foreigners, is said to have stated that the law may be expected to be so amended that where patents are granted to foreigners the patentees will be compelled to work them in the country. A certain period will be fixed within which foreigners would be placed under the obligation either to work the patents themselves or to grant licenses to persons in the United Kingdom to do so. In the event of failure to make one of these arrangements within the stipulated time, the patent would become void. In Germany there is also a somewhat similar arrangement, although the law is not definite enough to prevent it from being easily circumvented.

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RAILWAY MACHINERY

A SPECIAL EDITION OF MACHINERY FOR THE RAILWAY SHOP, DEVOTED TO LOCOMOTIVE AND CAR EQUIPMENT AND MECHANICS.

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We solicit communications from practical men on subjects pertaining to railway machine shop practice, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

APRIL, 1907.

BILL LIMITING HOURS OF LABOR OF RAILWAY TRAINMEN.

On our editorial page last month we called attention to the bill introduced into the Congress by Senator La Follette of Wisconsin. The bill was passed by the Congress before the appearance of the March issue, and a rigid enforcement of the measure is what is now to be hoped for. The bill contains in short that railroad employes shall not work more than 16 hours in any 24; that railroad employes shall have eight or ten hours continuous rest in any 24; that train dispatchers shall not work more than nine hours in any 24; that in day and night offices telegraph operators shall not work more than nine hours in any 24, and where day offices only are maintained, not more than 13. Every violation of the law shall be punished by a fine not exceeding $500. The law takes effect March 4, 1908.

* * *

WIDER GAGE FOR RAILROADS.

After his grilling at the inquisition instituted by the Interstate Commerce Commission in March, Mr. Edward H. Harriman, the present railroad colossus, seems to have had a change of heart and instead of maintaining a sphinx-like silence he professes to believe in a policy of taking the public into his confidence. In a recent interview given in Washington he made what will strike the practical railroad man as about the most remarkable utterance that could emanate from such a prominent financier, and that was that the railways of the United States will eventually have to be rebuilt to a gage of 6 feet in place of the present gage of 4 feet 8½ inches. On this wide gage Mr. Harriman would run cars 2 feet wider and 2 feet higher than the present road limit permits.

To others who know something of the enormous difficulties of changing a habit, custom or measure it seems that Mr. Harriman's statement is one that can scarcely ever be realized, even if it were desirable. The great cost and enormous physical difficulties to be encountered in such project would well make the stoutest heart shrink; and there are those who would seriously question the possibility of any economic gain that could follow the change to the broad gage of 6 feet. Probably if railway builders were starting new to-day they would adopt a gage slightly wider than the present standard, possibly making it 5 feet, but that they would make it as wide as 6 feet we very much doubt. What would be easier and which would accomplish nearly all that could be accomplished with a 6-foot gage is to simply increase the present loading gage all around, and then build the cars wider and higher than now. Setting the wheels further apart serves no good purpose save that of somewhat increasing the stability of locomotives and cars, but there are disadvantages resulting from a wider gage. The trucks must be built wider, and longer to prevent slewing, otherwise train resistance would be enormously increased, and doubtless this would inevitably follow, for we believe the nearer a car can approach the bicycle type in the matter of wheel support the less will be its rolling resistance. If it be possible to considerably increase the present loading limits by improving the tracks it should be seriously considered for it is the first step to an increase of gage anyhow.

* * *

WHY ARE MACHINE PARTS MADE INTERCHANGEABLE?

Strange as it may seem, a not inconsiderable number of people have the idea that sewing machines, guns and other articles of trade built on the interchangeable system are so constructed for the convenience of the user in case of breakage of parts. However, this curious idea is not so strange when it is known that certain manufacturers carefully foster it in the minds of their customers, stating in effect that while the system of making a machine interchangeable costs *more*, it is done solely to improve the character of the product and make repairs easy. For example, one company in the East, claiming to be the largest manufacturer of firearms in the world, states in its general catalogue that all parts of its arms are made interchangeable and that each piece is tested with gages from one to forty times. Then follows: "This system of interchangeable parts materially increases the cost of producing guns, nevertheless they are sold cheaper than guns made in a less costly and less careful manner." Presumably this statement is made for public consumption and not for the critical attention of experts, but is distinctly misleading, and in bad taste. We all know, who know anything about manufacturing, that the interchangeable system on a large scale does not increase the cost of production for the same grade of product, but on the contrary materially decreases it. So well known is this fact to *our* readers that it seems absurd to be called on to make such a statement in the editorial columns. Supposing interchangeable manufacturing actually does increase the cost of production, then it is the most monumental failure that we know of—but we do not need to suppose. The convenience of being able to readily replace a broken part is *incidental* although interchangeability is the fundamental of the system.

* * *

IMPROVED SPIKES FOR RAILWAY TIES.

The recent terrible accident on the New York Central electric suburban service which cost the lives of twenty-three people, calls renewed attention to the need of better means of holding rails to the ties. Recent tests, made by the Forest Service of the U. S. Department of Agriculture, given in a recent bulletin, demonstrate that the screw spike, used on the French and other continental railroads and by the Illinois Central in the United States, is far superior in holding power to the common spike generally used in this country. The tests referred to were made with the common spike, the screw spikes used abroad, the channel spike, and the Illinois Central spike which is very similar to the foreign screw spike. It was found that screw spikes resist withdrawing with from two to three times the force required for pulling the common spike. The channel spike, which as the name implies is made with a longitudinal groove on one side, is somewhat superior to the ordinary spike, having about 12 per cent greater holding power, and being considerably lighter. It, however, is not in the same class with the screw spike, especially if the ties are knotty. In the case of a knotty tie, a common spike has 25 per cent less holding power than in a clear tie, whereas the screw spikes have 35 per cent greater holding power than for the same spike screwed into a clear tie. With the growing scarcity of timber and the necessity for using some inferior stuff, the importance of obtaining good holding power makes the screw spike of still greater value than under the old conditions when first-class timber was cheaply available for tie purposes. The labor of applying the screw spike is, of course, considerably greater than with a driven spike. A hole of a diameter equal to that of the screw at the bottom of the thread must be bored with a bit and then the spike is screwed home with a socket wrench, but the cost of maintenance-of-way must necessarily increase in far greater ratio if the common spike continues to be used.

PRINCIPLES OF DESIGN.

ENTROPY.

The designer to whom you refer in the editorial "Principles of Rational Design," which appeared in the Engineering Edition of the February issue, evidently believes the millennium to be sufficiently near at hand to be worth talking about. The cut and try method of design which you and he apparently expect to see done away with has been a mighty safe, though slow, process. It is the process by which has been done almost everything that has been done, notable exceptions being found in the fields of chemistry and electricity, where theories based, however, on the results of cut and try methods, have been the means of safely predicting the existence of hitherto unknown metals, or the means of producing designs by following set rules. An attempt to do what your designer suggests, will show at once the futility of attempting to fly straight at the mark in the present state of mechanical engineering. A few elementary things are well understood. The action of cams, of gears, and of link designs is easily predicted, and within reasonable limits their performance under severe duty as to wear and continued truth of action is assured, but when it comes to a choice, say of whether a certain motion in a machine shall be obtained by one form of cams or another or by gears or link work, then the problem becomes one which may permit of numerous solutions, any one of which may best suit a certain combination of other parts of the machine. Thus it may be possible to get a large number of different combinations of elements in a machine for producing certain definite results, all of which may work with equal efficiency. I have in mind just now a certain machine in the design and evolution of which I have had a hand. It is used to fold a peculiar material very much as envelopes are folded. After the folding, the finished product was to be stamped and pressed. The machine was built as a folder with a light press attachment as a subsidiary part. One piece in five minutes was all that we hoped to get. Experience with this machine showed that it could be run several times as fast as this, but that if we did so, the press was entirely inadequate. I have just redesigned this machine, and now it is a press with a folder attachment. I am not at liberty to say anything definite about this particular machine, but so far as I can find out there was and is no published data on which I could have based my conclusions so that I might have designed a better machine the first time. There was neither money nor time to do any experimenting with the material. The machine was designed on clear horse sense, nothing else. The second machine had no theory in its make up, except the theory that if the first one would do the work with an occasional breakdown, the second would stand up if made several times as strong. We are up to the limit of human endurance now to feed the machine. If we get up an automatic feeder we may have to redesign it for still greater capacity. The first machine may be said to have been designed all on theory, and when a practical man gets going on theory he runs wild. When you come to think of it, the worst lot of theory that you can strike comes from hard-headed practical men that don't know a sine from a wooden Indian. They have their practical experience, but they are dead sure that everything that looks just a little like a wheelbarrow runs just like one, wherein they are just as apt to run into trouble as the college chap that says it is a unicycle.

But to get back to the subject—when there is such a fund of experimental knowledge at hand that a certain set design has been found and proven by long use to be reliable—for instance look at bicycles—then the day of the designer is gone. There was a day when the expert bicycle designer was at a premium. He worked by horse sense too; now we know where the limits are, and we can have a good designer in that particular line for two dollars a day, unless they have all died or got into other lines of work; or better still, we can go and get a wheel by some good maker and change one or two dimensions and put it out as a new wheel. Just so long as design is uncertain, the skilled designer, the man who knows things mechanical, can draw a good salary, but as soon as a design may be predicted, so that there is only one design to suit one set of requirements, then the true designer leaves it for new fields, and the office boy turns out the designs by the aid of a set of formulas.

* * *

ALCOHOL, KEROSENE AND GASOLINE AS FUELS FOR AUTOMOBILES.

Automobilists who have been looking for practical tests upon which to base definite conclusions on the use of denatured alcohol as a satisfactory fuel, will find much to appreciate in the technical report just compiled by the official observers who accompanied the three Maxwell cars in their recent comparative fuel test run from New York to Boston. One of the cars used gasoline, one kerosene, and the other denatured alcohol. Under the strenuous conditions in which the run was accomplished, through snow and over bad roads, the results were far more successful than had been expected.

The main object of the test was to demonstrate that a modern gasoline car can be run successfully on alcohol or kerosene, if necessary, and to bring out the relative cost of operating it on either of the three fuels. But the greatest interest in the test was centered in the showing of the alcohol car, for it was the first attempt since the denatured alcohol law went into effect to make a long distance test under the official inspection of a committee of experts. The total distance traveled was 249 miles, long enough to allow of accurate comparison between the three fuels. The power developed by the engine using alcohol seemed fully equal to that developed when it was run with gasoline, and the pulling qualities of the engine when its speed diminished under load were remarkable, being the nearest approach to a steam engine that the committee of inspection had so far observed. This, of course, depends upon, that while the initial pressure obtained from alcohol is less than with gasoline, the mean effective pressure is greater. Despite the fact that the alcohol machine was the most heavily loaded, it opened its way through the snow and kept well ahead of the other cars. There seemed to be nothing lacking in power and speed. The kerosene car, too, showed good power and speed. Because of the lubricating qualities of kerosene the driver was able to run his car half of the distance without the use of lubricating oil in the cylinders. On account of its low cost kerosene would no doubt come into wide use, especially for commercial work, if some form of carbureter were introduced that would thoroughly gasify the liquid. Even though the consumption was great, on account of the low cost of kerosene it was the cheapest of the three fuels used. The car running on kerosene averaged 7.4 miles per gallon; the one using alcohol 6.13 miles, and the one using gasoline 10.1 miles per gallon of fuel used. The following table, showing the cost of the different fuels per gallon, and cost per ton-mile for each car, gives a good general idea of the comparative value of the different fuels:

	Weight.	Cost per Gallon.	Total Consumption, Gallons.	Total Cost of Fuel.	Cost of Fuel per Ton Mile.
Gasoline	2,270	$0.20	24.75	$4.95	$0.0169
Kerosene	2,520	0.13	33.75	4.39	0.0139
Alcohol	2,750	0.37	40.75	15.07	0.0448

From the above table it is seen that alcohol in its cost per ton-mile is about two and a half times as expensive as gasoline, and over three times as expensive as kerosene when used in the gasoline engine of the present day.

* * *

In a recently issued catalogue on high-speed drills the Cleveland Twist Drill Co. states that its tests and observations lead to the conclusion that it is well to start a high-speed drill at a peripheral speed of between 50 and 60 feet per minute (say 240 R. P. M. for a ⅞-inch drill), and to feed from 0.005 to 0.010 inch per revolution for drills over ½ inch diameter. Should the drill be running too fast it will wear away at the corners of the lips, and if the feed is too great the cutting edges will break or chip. When used in steel or wrought iron the drill should be flooded with lubricant or cutting compound; in brass use paraffine oil; and in cast iron an air blast. Spring in a drilling machine is very likely to cause broken drills when the point breaks through. Hence the high cost of high-speed drills makes it very important that they be used only in stiff, rigid machines.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The railway mileage of any country may be considered as a fair indication of its growth. That China is rapidly developing along the lines of western civilization is evident from the fact that the country now has 9,000 miles of railway in operation or under construction. According to the *Railway Age*, the Chinese Imperial Railways, 526 miles, paid 20 per cent on the capital outlay.

A 1,000 H. P. steam turbine installed in the locomotive works of J. A. Mäffei, Munich, Bavaria, by Melms & Pfenninger, G. m. b. H. of Munich, was tested by Prof. Schroeter. At 2459 R.P.M. and a load of 500 K.W. it showed a steam consumption of 17.1 pounds per kilowatt hour. The steam pressure was 176 pounds gage and the steam temperature was 319.4 degrees Centigrade. The design of the turbine is a combination of the impulse and reaction types.

According to the *Scientific American*, Germany is at the present time the leading country in the manufacturing and use of alcohol for light and power. Potatoes are the chief source from which alcohol is produced. One-eighth of all the tillable land in Germany is planted with potatoes and the yield is valued at $60 per acre. Nearly half of the whole crop is used in the manufacture of alcohol and starch. In France alcohol for manufacturing purposes is made chiefly from molasses and sugar beets.

According to *The Locomotive*, the total number of boiler explosions in 1906 was 431, which is 19 fewer than were recorded for 1905. There were 450 in 1905, 391 in 1904, and 383 in 1903. The number of persons killed in 1906 was 235, against 383 in 1905, 220 in 1904, and 293 in 1903; the number of persons injured in 1906 was 467, against 585 in 1905, 394 in 1904, and 522 in 1903. The average number of persons killed, per explosion, during 1906, was 0.545, and the average number of persons injured, per explosion, was 1.083.

Initial shipments of denatured alcohol have been made from distilleries in Peoria, Ill., being quoted at 31 cents per gallon, which will amount to about 36 to 37 cents in New York. The denatured alcohol bill having been in force only three months has had a remarkable influence on the price of wood alcohol, this latter having, according to the reports of the Department of Commerce and Labor, dropped from 75 to 45 cents. Evidently there must have been more or less of a monopoly in the manufacture of wood alcohol, when competition has been able to cut the price nearly in half within so short a time.

The speed of battleships will probably be subject to less variation than any other characteristic in the future. The speed of modern types of hulls may be represented very accurately by the formula:

$$S = 6.35 \sqrt[3]{\frac{H.P.}{D^{\frac{2}{3}}}}$$

where S is the speed in knots, $H. P.$ is the horsepower of the engines, and D is the displacement in tons. Designers seem at present to be of the opinion that the best results are obtained in the matter of all-around fighting efficiency by allowing 1 horsepower for each ton of displacement.—*Forrest E. Cardullo in Scientific American.*

During the months of August and September, this year, there will be held at Amsterdam, Holland, an international exhibition of machinery, machine tools and motors of various kinds. The exhibit is held under the auspices of the Society for the Advancement of Industry and is supported by the Dutch government and the city of Amsterdam. The exhibits are to be exempt from import duty. As Holland is a low-tariff country and with no important mechanical industry of her own, it seems as if this exhibit might offer a fair opportunity for foreign firms to introduce their goods in the Dutch market. Intending exhibitors are asked to communicate with Mr. T. M. Massis, Heerengracht 357, Amsterdam.

The wireless electric current transmission is now claimed to have made possible the production of electric light at a distance from the source of electrical energy. It is said that the Danish inventor, Valdemar Poulsen, who is well-known for his development of wireless telegraphy, has demonstrated before an audience of English scientists the possibility of wireless electric light. It is likely that some of the startling news in relation to the possibility of wireless transmission of electric current must be accepted with reservation, but there is no doubt that the developments of this branch of the electric science will prove to be one of the most important and, we might say, most wonderful.

After a long time of laborious research and experiments, two Belgians, Monge and Arzano have succeeded in perfecting a process by which they are enabled to metallize objects of very fragile nature, such as, for instance, fine laces, or a rose in full bloom. They have established a factory at 17 Rue d'Irland Saint Gilles, Brussels, with the object of placing finely finished metallized objects on the market, in every particular equal to, but at one-eighth the cost of, cast bronze. The process permits of perfectly duplicating the incomparable forms nature gives to her products, such as flowers, leaves, fruits, etc. The articles to be metallized are retained in a bath form 24 to 72 hours, and the finished articles appear to be made out of solid bronze.

According to the *Cologne Gazette* a new ocean liner will soon be built for the Hamburg-American Steamship Co. in the yards of Harland & Wolff at Belfast, Ireland. The new vessel is to be called the "Europa," and is expected to be launched in 1908. She will have luxurious passenger accommodations, including Turkish baths, elevators, a tennis court on the promenade deck, and a swimming tank, 75 x 25 feet. There will be accommodations for 550 first-class passengers, 350 second-class, 1,000 third-class, and 2,300 steerage. With the 500 men required for the crew, the vessel will carry 4,700 persons, the largest of any of the transatlantic liners. The new vessel will have a speed of 19 knots, a displacement of 42,000 tons, a length of 750 feet, and a beam of 80 feet.

The Metropolitan Life Insurance Co., New York, has announced its plan for a 50-story tower which will rise 690 feet from the foundation. It will be built in completion of its marble office building covering the block between Madison and Fourth Avenues and 23d and 24th Streets. It will be five stories higher than the Singer Building tower now in process of construction. The tower will have 75 feet frontage on Madison Avenue and 85 feet on 24th Street. The height above the sidewalk will be 658 feet. A huge clock face will be a feature of the tower at a height of 346 feet above the sidewalk. The dial will be 25 feet in diameter and the hands 12 feet long. Six express elevators will be installed in the tower, four of which will terminate at the 42d story.

Japan is immensely rich in water power, the aggregate of which is estimated at some 1,000,000 horsepower. More than a hundred smaller waterpower installations are already in existence, and some very important ones are being constructed. Among the latter is a power station for Kioto, with a canal of 7 miles in length, and a fall of 110 feet. The capacity of this station will be 4,400 horsepower. The power station for Tokio, on the Tamagava River, will have 20,000-kilowatt transmission, with a 40,000-volt tension, over a distance of rather more than 25 miles. Another large station will be placed between Kioto and Osaka, which towns lie at a distance of about 40 miles, and this installation is calculated at 32,000 kilowatts. Japanese enterprise has also brought some waterpower installations into Korea.—*Engineering.*

The manufacturers of an English motor car, known as the Siddeley, have introduced a substitute for the pneumatic tire. Although it is doubtful whether the new introduction altogether solves the difficulty due to the liability of puncture of the ordinary tire, there is no question that the new tire acts as an excellent compromise, and at the demonstration given in London some extraordinary results were obtained. The new tire is known as the elastes tire, and has derived its name from a solution called elastes, which consists of glue, glycerine and chromic salts mixed at a high temperature. This mass injected into the inner tubes used with the covers of ordinary pneumatic tires solidifies in a few days into a soft rubber, rendering the combination a soft cushion tire fit to combat roads of all conditions. The advantages claimed for "elastes" filled tires are entire immunity from puncture, longer life of covers, and ultimate saving in running cost. It is calculated that a set of elastes tires will run for at least 10,000 miles fitted to a 24 horsepower car. The experiments prove that half the price of tires can be saved through the use of "elastes." From this it would appear that a decided step has been taken toward a perfect type of tire.

Assuming the steam consumption of the turbines of the new Cunard steamship *Lusitania* to average 15 pounds per horsepower-hour when the turbines are developing 65,000 H.P., it has been calculated that the boilers will have to evaporate each hour 435 tons of water, which would call for the consumption of 50 tons of coal per hour, or 1,200 tons per day. As the turbine requires for economical working a high vacuum it is assumed that the condensers will call for about 50 pounds of circulating water for each pound of steam condensed. This means an hourly passage of 21,750 tons through the circulating pumps, or 522,000 tons per day. Each pound of coal consumed will require the passage through the furnaces of 14 pounds of air, making a total of 700 tons per hour, or 16,800 tons per day. This is equivalent to 21,000,000 cubic feet of free air per hour. With the average trip estimated at five days it will be seen that the coal consumed will amount to 6,000 tons. The water evaporated will total 52,200 tons. The work of the circulating pumps will be represented by the passage through the condensers of 2,610,000 tons of water, or 60 times the entire weight of the ship and contents. The air required for the furnaces will be 84,000 tons.—*Iron Age.*

Denatured or industrial alcohol is sold by the Swiss government at cost—about 25 cents per gallon. There are two methods of denaturizing the alcohol, the complete and the incomplete. The complete method is applied to spirits which are to be used for heat, light, and power purposes. This alcohol is fully denatured; pyridin is used as a base. Incomplete denaturization prevents the alcohol from being used as a beverage, but does not destroy its properties for special uses. The process of denaturizing varies according to its intended use. To each 100 parts absolute alcohol the following substances are added: (1) For vinegar: 5 parts absolute acetic acid mixed with at least 200 parts water. Wine or beer may be substituted for the water. (2) For varnish, polishes, etc.: 2 parts wood alcohol and 2 parts benzine, or ½ part turpentine oil, or 5 parts wood alcohol, or 4.4 pounds shellac, or 4.4 pounds copal rosin, or 1.1 pound camphor. Camphor may be used only by firms using the finished product in their own factories exclusively. (3) For paints and colors: 10 parts sulphuric ether, or 1 part benzol, or 1 part coal-tar oil, or ½ part turpentine oil, or 25 grammes bone oil, or 25 grammes aniline blue (or eosin, or violet, or fluorescin), or 100 grammes naphthaline, or 4.4 pounds technically pure methyl alcohol, or 1.1 pound camphor.

CONDITION OF STEAM TURBINE AFTER LONG TIME OF SERVICE.

Power, December, 1906.

After eleven months' run a turbine in the power station of the Baltimore Power Company was dismantled for the purpose of inspection. A thorough examination after so long a time of more or less constant service shows the following results:

The general condition of the machine was found to be as good as it was at the start; no blades were found missing; the blades were in excellent condition, although a slight surface oxidation was noticed, due to condensed steam remaining in the cylinder while the machines were out of commission; the bearings showed no wear; nor was there any wear on the shaft; in fact, the original marks of the scraper tools were plainly visible over the entire wearing surface of the bearings, which proves that the rotating element is supported on oil films; the governing mechanism was perfect, with the exception of two inexpensive knife edges, which were replaced; lost motion had not developed in this device, and the governing was as positive and sensitive as when first installed.

The whole plant referred to has been running for a year with twenty-four hours' service; no troubles of serious nature have arisen, and practically no repairs have been necessary excepting of a minor character. Once one of the bearings ran warm, but this was due to shortage of oil in the lubricating system. A copper expansion joint located on one of the equalizing pipes fractured, but no trouble resulted, and it was replaced by another. These facts being taken into consideration, it is the opinion of Mr. Josselyn, the vice-president and manager of the operating department of the Baltimore Power Company, that from an operating standpoint the steam turbine has proven eminently successful for central station service.

MAKING ALCOHOL FROM SAWDUST.

The Engineer, Chicago.

Wood alcohol is made by the dry distillation of wood, that is, by heating wood in the absence of air, under which condition vapors are given off and charcoal left behind. The vapors are then cooled and condensed to a liquid, which is separated into its constituents, one of which is wood alcohol. Some 50 years ago a chemist discovered that by boiling sawdust for a long time in a fairly strong acid, it produced a sugar which could be fermented to ethyl alcohol. The yield he obtained, however, was too small to make the process of any commercial value. The first process to have even a vestige of commercial value was that of Simonson, a Swedish chemist, who proposed to treat the sawdust in three times its weight of strong sulphuric acid at a high temperature and pressure. Even this method, however, was difficult and expensive and did not give a good yield of alcohol. A number of patents were issued which were merely variations of this process, among them being that of Classen, a German chemist, who treated the sawdust with strong acid and afterward submitted it to hydraulic pressure. Not satisfied, however, he went on, gradually perfecting a method, and finally about three years ago he patented a process which is now in successful operation in this country.

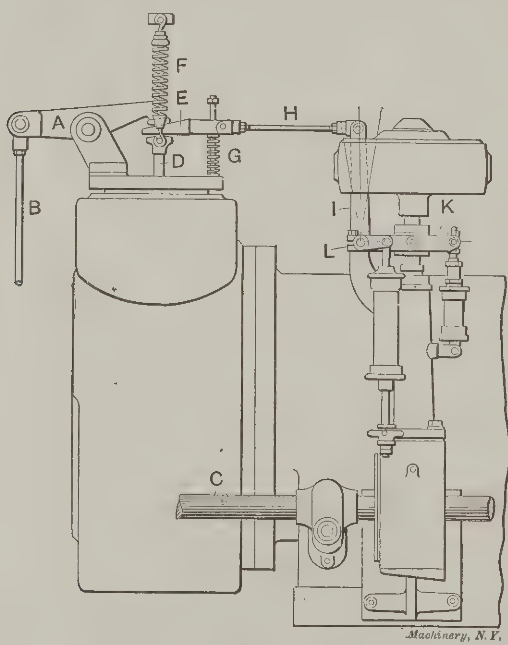
The process is, shortly, as follows: Sawdust, or wood waste, in pieces up to the size of a lead pencil is dampened and placed in a large cylinder which is lined with lead so as to resist the action of the acid used during the process. Sulphuric acid is then introduced in the proportion of one part 3 per cent sulphuric acid to three parts of wet sawdust. The cylinder is revolved in order to thoroughly mix the contents, which are rapidly heated up to 300 degrees F. The mass is kept at this temperature and under pressure for an hour. Then the steam and acid are blown off, and the acid is saved to be used again. The sawdust is thoroughly washed with water in order to abstract all sugar which has been formed. This solution is then treated with lime to neutralize the small amount of acid it contains and heat is added. Fermentation begins almost immediately and is practically complete after 8 hours. After the fermentation is complete, the liquor is distilled and the alcohol purified in exactly the same manner as the alcohol from corn, and the resulting product is ethyl alcohol, differing in no way from the best grade of ethyl alcohol produced from grain, potatoes or molasses. The yield is excellent, amounting to 25 gallons of absolute alcohol per ton of wood, and this value is about the same for all available woods.

GOVERNING DEVICE FOR INTERNAL COMBUSTION ENGINES.

The Mechanical Engineer.

This method of governing internal combustion engines, named after its inventor, A. R. Bellamy, of Stockport, England, is founded on the well-known method of the interposition of a wedge-shaped block between the valve stem and the lever actuating the valve.

As seen from the cut, a small lever *A*, which is oscillated by a connecting-rod *B* and crank or other mechanical device through the medium of a cam on the side shaft *C*, is fitted to a pivot. Between the free end of this pivoted lever *A* and the stem *D* of the valve admitting explosive mixture to the engine, is disposed a wedge-shaped or inclined block *E* interposed in such a manner that the pivoted lever acting on the wedge-shaped block brings the face of the same into contact with the stem of the mixture valve, thus opening the valve against the action of the spring *F* on each oscillation of the lever *A*. A compression spring *G* may be employed to maintain the wedge or inclined block *E* always in contact with the lever *A*. The inclined block *E* is pivoted to a spindle or rod *H* connected to a lever *I*. This lever *I* is secured to a rod *L* mounted in suitable bearings. To the rod *L* are also connected levers *K*, which are actuated by the governor of the engine. The oscillating movement of the levers *I* and *K*, indicated by light center lines in the cut, in answer to the calls of the governor, reciprocates the rod *H* and causes the wedge-shaped block *E* to be correspondingly moved laterally between the end of the pivoted lever *A* and the stem *D* of the mixture valve. When the load on the engine is light the levers *I* and *K* move the thinner end of the wedge *E* above the point of the stem *D* of the mixture valve, leaving a gap between the wedge and the valve stem. The pivoted lever *A* therefore oscillates the wedge *E* some little distance before the inclined wedge can come into contact with the valve stem *D*, and the mixture valve is opened to its smallest extent. This opening of the mixture valve is gradually increased to a maximum as the governor slides the inclined wedge until the thickest part of the wedge comes into contact with the valve stem. When the wedge *E* is pulled right away from between the valve stem and the oscillating lever, such as would happen if the engine "raced" or "ran away," the lever *A* would be incapable of opening the mixture valve at all, thus cutting off entirely admission of explosive mixture to the engine.



Governing Device for Internal Combustion Engines.

CONCLUSIONS AS TO THE STABILITY OF STEEL FRAME BUILDINGS.

Some interesting conclusions on the stability of tall steel frame buildings have been made public by Mr. Frank B. Gilbreth, a well-known contractor of New York City, who is at the present time reconstructing the eight-story steel frame Mutual Life building in San Francisco. He believes that there is no reason to fear structural damage in tall buildings in San Francisco or any other city by an earthquake as severe as that of April 18, 1906, provided the buildings are properly designed and constructed. The Mutual Life building which, though only eight stories, is taller than the average ten-story building, was built thirteen years ago on made ground, and passed through the earthquake without a structural blemish. However, the subsequent fire damaged it to such an extent as to necessitate the removal and reconstruction of the upper six stories. This gave the contractor an unusual opportunity to investigate the condition of a modern structural steel building which had been subjected to an earthquake shock and afterwards to a severe fire. The result of his investigation is given as follows:

1. A steel frame, properly painted and buried in masonry, will not rust enough in thirteen years to affect its strength any measurable amount.
2. The better the steel is coated with mortar the less it will rust.
3. Portland cement is better than lime mortar for imbedding steel to prevent it from rusting.
4. Unpainted iron rods buried in mortar composed of lime and a large proportion of Portland cement, rust very little, certainly not enough to impair their strength.
5. Columns should be of such cross section that they can be thoroughly imbedded in Portland cement, avoiding a hollow column unless latticed and filled with very soft concrete.
6. Wherever possible, preference should be given to those shapes of steel that present the least surface to the action of rust.
7. If steel is not thoroughly cleaned from rust before it is painted, the paint will not greatly retard the progress of the rust.
8. It is much easier to cover steel thoroughly with concrete than with brick masonry. If brick masonry is to be used the bricklayer should thoroughly plaster the steel work ahead of the brick work.
9. The quality of the paint used, though important, is not so important as surrounding every part of the steel with Portland cement.
10. Interior columns do not rust as much as exterior columns.
11. Cinder concrete does not injure to the slightest degree a steel floor beam that has been painted.
12. No pipes or wires should ever be placed behind fireproofing, as they will buckle with the heat and push off the fireproofing.
13. This building probably could have been saved intact if it had had fireproof exterior door and window-frame with wire glass and an emergency water tank on the roof.
14. Terra cotta blocks are not as good as concrete for fireproofing interior columns, nor do they protect the steel from rusting as well as does Portland cement concrete.
15. Neither marble nor any of the well-known kinds of plaster will withstand heat. There is a great demand for some durable material that can be worked as easily as can wood or plaster, but which will resist great temperature.

EFFECT OF DURATION OF STRESS ON STRENGTH AND STIFFNESS OF WOOD.

Trade Bulletin 10, Forest Service, United States Department of Agriculture.

It has been established that a wooden beam which for a short period will sustain safely a certain load, may break eventually if the load remains. For instance, wooden beams have been known to break after fifteen months under a constant load of but 60 per cent of that required to break them in an ordinary short test. There is but little definite and systematic knowledge of the influence of the time element on the behavior of wood under stress.

This relation of the duration of stress to the strength and stiffness of wood is now being studied by the Forest Service at its timber-testing stations at Yale and Purdue universities. The investigation will determine the effect of a constant load on strength, the effect of impact load or sudden shock, the effect of different speeds of the testing machine used in the ordinary tests of timber under gradually increasing load, and the effect of long-continued vibration.

To determine the effect of constant load on the strength of wood, a special apparatus has been devised by which tests on a series of five beams may be carried on simultaneously. These beams are 2 x 2 inches in section and 36 inches in length, each under a different load. Their deflections and breaking points

are automatically recorded upon a drum which requires thirty days for one rotation. The results of these tests extending over long periods of time may be compared with those on ordinary testing machines, and in this way safe constants, or "dead" loads, for certain timbers may be determined as to breaking strength or limited deflections.

The experiments of the Forest Service show that the effects of impact and gradually applied loads are different, provided that the stress applied by either method is within the elastic limit of the piece under test. For example, a stick will bend twice as far without showing loss of elasticity under impact, or when the load is applied by a blow, as it will under the gradually increasing pressure ordinarily used in testing. These experiments are being extended to determine the general relations between strength under impact and gradual loads.

Bending and compression tests to determine the effect of the speed of application of load on the strength and stiffness of wood have already been made at the Yale laboratory. The bending tests were made at speeds of deflection varying from 2.3 inches per minute to 0.0045, and required from twenty seconds to six hours for each test. The woods used were long leaf pine, red spruce, and chestnut, both soaked and kiln dried. From the results are obtained comparable records for difference in speeds in application of load. A multiplication of the results of any test at any speed by the proper reduction factor, derived from these experiments will give equivalent values at standard speed. The tests also show concretely the variation of strength due to variations of speed liable to occur during the test itself. The results plotted on cross-section paper give a remarkably even curve as an expression of the relation of strength to speed of application of load, and show much greater strength at the higher speeds. A numerical expression of the law, averaging all species, both wet and kiln-dry, gives the following table, which shows the increase in strength with the increase of speed of test:

Minutes to Move	Ratios of Ultimate Strength.	
Crosshead one inch.	Compression.	Bending.
900	100	100
350	100.8	100.9
150	102.3	107.3
40	106.9	110.1
5	113.8	118.7

The first column, which gives the number of minutes required to move the crosshead of the testing machine over the space of one inch is the reciprocal of speed. The second and third columns give the effect of this increase of speed upon compression and bending, respectively, and show that strength increases with speed. The strength at the lowest speed is arbitrarily fixed at 100 as a convenient basis for comparison. The ordinary bending-test speed for small specimens is one-tenth inch per minute, or, reciprocally, ten minutes are required to move the crosshead one inch.

It is common belief among polemen that the continual vibrations, to which telephone poles are subjected, take the life out of the wood and render it brash and weak. Nothing is definitely known as to the truth or falsity of this idea. Tests will be undertaken to determine the effect of constant vibration on the strength of wood.

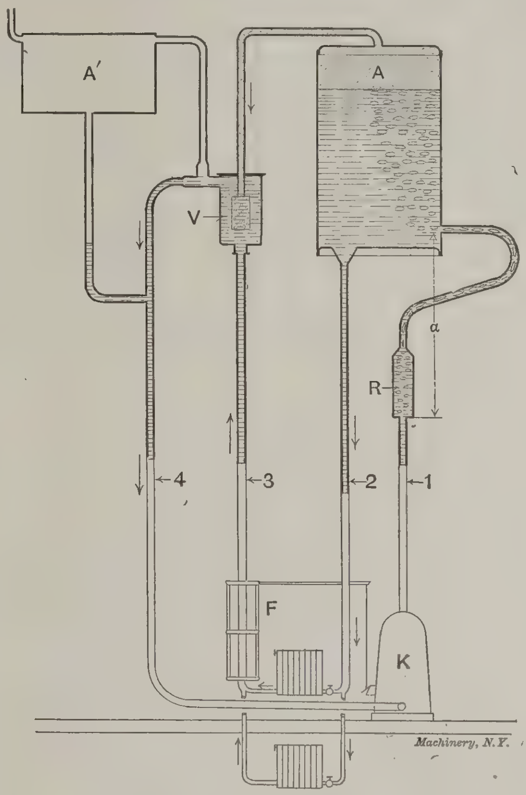
A RAPID CURRENT HOT WATER HEATING SYSTEM.

Engineering News

A rapid-current heating system has the advantage that small pipe may be used with consequent lower cost in constructing the pipe circuits as compared with ordinary warm-water heating systems. Such a system has recently come into extensive use in Germany and England, and is known as the Brückner system, after its inventor. The rapid circulation of the water is produced by a short length of pipe in which steam separation and emulsion take place.

Referring to the cut, *K* represents the boiler, *R* the regulator, *A* a closed expansion tank, *A′* an open safety tank, *V* the condenser and *F* the draft regulator. The boiler is in direct communication with the safety tank *A′* through the return pipe No. 4. Thus the system is of the open warm-water type. When the temperature of the water leaving the boiler rises above the boiling point, vaporization begins in pipe No. 1, steam bubbles are formed in the rising pipe, and the flow to the expansion tank *A* is composed of a mixture of water and steam, the specific gravity of which is much less than that of water alone. In expansion tank *A* the steam bubbles rise to the surface of the water, and the pressure forces them through the pipe at the top of the expansion tank to the condenser, while the heated water containing no steam, finds its way to the radiators through pipe No. 2.

Disregarding the difference in specific gravity between the water columns in pipes 1 and 4, and 2 and 3, it follows that the circulation power, or motive force, obtained depends entirely upon how much the total weight has been reduced by the length of the column of mixed steam and water, *i. e.*, by the specific gravity of the emulsion column *a*, if we assume that separation begins, under normal conditions, near the



Rapid Current Hot Water Heating System.

lower edge of the regulator and that the rising pipe enters the expansion tank *A* just above its bottom. In the Brückner system, at least with moderate circulating heights, it is claimed that only about two-fifths of the sectional pipe area is required compared with a low-pressure steam heating system of the same capacity.

The water flows into the radiators, as a rule, at a temperature of about 210 degrees F., and as the water should always enter and leave the radiators from below whenever possible, the average normal temperature of the water in all the radiators will be about 185 degrees F. The second expansion tank *A′* is simply a safety tank for equalizing the pneumatic pressure produced by firing, and for the purpose of receiving an extra flow of water caused by too hot a fire.

MAKING SEAMLESS STEEL TUBES.

The following article on the manufacture of seamless steel tubing, for boiler tubes and other purposes, is taken from the *Pittsburg Dispatch*, a daily newspaper. While not at all technical, it is as good a description of the process as could be given without going into details at great length. The plant spoken of is the Shelby Steel Tube Company's mill at Greenville, Pa.

The steel reaches the tube mill in blooms six inches square, each weighing about 750 pounds. This bloom is put into a continuous heating furnace, which has a capacity of 150 blooms, and remains there until ready to be rolled. It is then taken from the furnace by an automatic conveyor to what is known as the 20-inch bar mill. Here the bloom is rolled into a solid round billet about 3½ inches in diameter. From the rolls the billet is carried by conveyors to the hot saws, where

it is cut to the required length of about 37 inches, each piece weighing somewhere near 80 pounds. These smaller billets then go through an underground passage to the steel yard, where they are stacked in piles and allowed to cool. The systematic inspection of the tubes begins at this stage of their manufacture. Company inspectors here give each section of the steel a slight inspection before it is transferred to the furnace which heats it for the piercing operation, the most important step in the making of seamless steel tubes. In this furnace the steel is brought to almost a welding heat, is taken from the furnace and put into the rotary piercing mill, which revolves the billet at 1,500 revolutions a minute, at the same time forcing it over a plug, and in fifteen seconds the solid steel billet is converted into a seamless tube nearly 8 feet long, 4 inches diameter and ¼-inch wall.

The tube is now picked up by another automatic conveyor and carried to the reheating furnace, where it is again brought to almost a welding heat and then carried to the two-high rolls, where it is subjected to six operations over a plug, elongating the tube to a length of about 19 feet, reducing its outside diameter to 3¼ inches, and the thickness of wall to 7-32 inch. The tube is next taken to the pointing hammers, where it is pointed for the cold-drawing operation, and after this it goes to the pickle house, where it is put into a strong solution of boiling blue vitriol acid which removes all scale and cinders or other foreign matter, leaving the surface absolutely smooth. A composition of tallow and flour is then applied to the tube, giving it a coat to reduce the friction during the cold-drawing.

After waiting long enough for the grease to dry, the tube goes to the draw bench, where it passes through the first cold-drawing operation, which consists of putting into the tube a mandrel and then drawing it through a round die. This process, by stretching the metal, elongates the tube, thins the wall, and smooths it both on the inside and outside. After the first cold-drawing, the tube is taken to the open-furnace annealing oven, where it remains for about half an hour, or until thoroughly annealed. Then the tube is again put through the pickle solution to take off the scale and dust accumulated during the annealing. It is again given the tallow and flour treatment, and taken to the draw-bench. This is repeated until the tube is of the required diameter and gage.

The tube is now ready for the finishing department, where it passes through the final operation before the first government inspection. This consists of straightening and cutting to length. At the first inspection the government inspector is required to examine each separate tube for surface and gage; from each one hundred tubes thus inspected he picks at random one tube for the elongation test, and two or three short pieces to be used for the crushing and flattening tests. These are stamped with the government stamp, and taken, with the other tubes to be again annealed, to a retort furnace; this because no air is allowed to strike the tubes during this last annealing or the cooling which follows it. When cold the tubes are removed from the retort and go to the straightening machines, where they are straightened for the last time. They then go to the shipping room to await the government test for elongation and strength. B.

CENTRIFUGAL PUMPS.

Abstract of Part of Paper Read by William G. Gass before the Manchester (England) Association of Engineers, December 7, 1906.

The credit of bringing the centrifugal pump on to a working basis is usually given to Appold, but long before his time, however, the centrifugal fan was at work, for as far back as 1713, Papin, the celebrated French engineer, designed one, and others have been made, both in England and America.

In the development of centrifugal pumps a variety of types have been evolved, but in all cases the pump consists of an outer portion, referred to as the casing, in which the inlet and outlet passages are formed, and which encloses a revolving wheel, impeller, fan, rotor, disk, runner, piston or bucket, these being various names for it.

Classes of Centrifugal Pumps.

Centrifugal pumps may be divided into four general classes or types which we, for simplicity, will refer to as types *A*, *B*, *C* and *D* respectively. Two sections of type *A* are shown in Fig. 1; the bucket is shown by dotted lines. This type has a single inlet central to the casing. It has no expanding chamber and is usually made only in smaller sizes, say up to about 6 inches diameter of inlet and outlet. The outlet is, as a rule, placed vertically as shown. The casing is divided in the center and the two halves bolted together. Fig. 2 shows a variation of this type with expanding chamber, and with an elbow fitted to the inlet which sometimes is used to form a support for the end of the shaft and provided with a stuffing box and gland. Type *B* is shown in Fig. 3. This

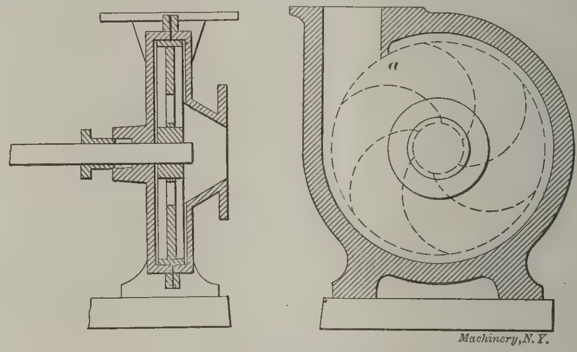


Fig. 1. Centrifugal Pump—Type A.

type is quite popular, and pumps are made after this pattern up to the largest sizes. The inlet and outlet shown at right angles may be made at any angle in regard to one another. The casing is divided in the horizontal and sometimes also in the vertical center line, and in some cases a segment is fitted which permits the bucket and the shaft to be lifted out. In this type the expanding chamber is provided for by the eccentricity of the axis of the shaft with regard to the external periphery of the casing, and in the larger sizes by the additional widening of the body toward the outlet. The inlet is branched and the incoming water divides into two streams, giving what is known as the double inlet or balanced type, the idea being that the two streams of water entering from opposite sides balance themselves and remove any end thrust on the shaft.

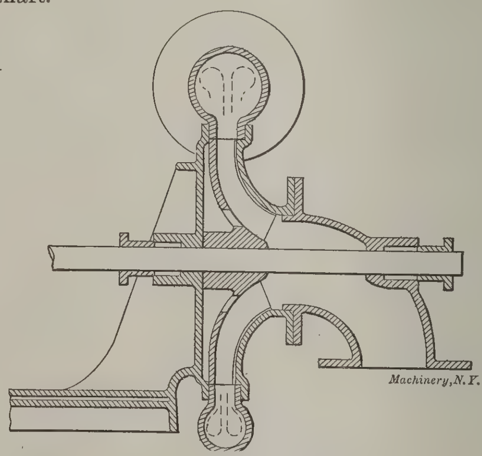


Fig. 2. Centrifugal Pump—Variation of Type A.

Type C, Fig. 4, is another form of the balanced or double inlet type, in which the expanding chamber is external to the diameter of the bucket and circular in section, but of increasing diameter, the space between the tip of the bucket arms and the expanding chamber being approximately parallel in section and circular in form. Type D, Fig. 5, has a single inlet, the expanding chamber developing external to the diameter of the bucket, but the continued development of which is carried out behind that part of the casing against which the bucket runs. The cuts of these four types show them all with the shaft horizontal and the buckets vertical, but they will any of them work equally well with the shaft vertical and the bucket horizontal; they would then, however, require some special form of bearing to carry the weight of the shaft.

Construction of the Bucket.

Our next point for consideration is the bucket, the portion of the pump which may be said to do all the work. We find that there are two classes of buckets only, which are, the closed type, Fig. 6, and the open type, Fig. 7.

In the closed type the vanes are carried from the hub but are covered in on either side, leaving a space in the center on each side through which the water enters, and is confined between these covers until it leaves the bucket and is discharged into the casing; a dividing plate attached to the arms prevents the two streams coming directly in contact as they enter the bucket. This type of bucket is used in pumps of Type B, and is occasionally used in a modified form in both forms of Type A, in which case it has a single inlet only. In the open type, which is generally used in pumps of Type C and D, the vanes are not enclosed, but run between the faces of the casing which encloses them, and when used in the double inlet pump have a dividing plate to prevent the entering streams striking each other. The cut shows a bucket of the double inlet type, but they are made of the single inlet as well.

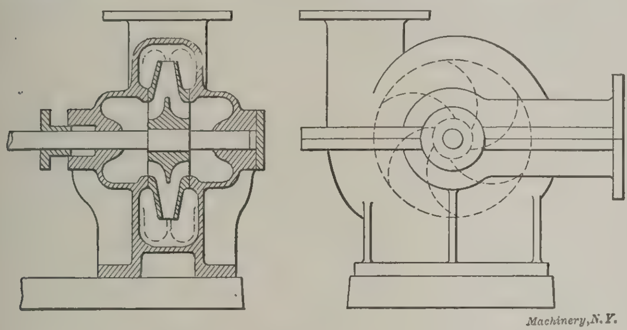


Fig. 3. Centrifugal Pump—Type B.

In both types the vanes are generally curved backward to the direction of rotation, although occasional makers use straight arms inclined backward in a similar manner; they are usually six in number, though four and eight are sometimes used, and occasionally, though very seldom, more than that number. The radius of curvature is given differently by different writers on the subject, but makers seem to each arrive at a form of curve which they find suits their requirements best.

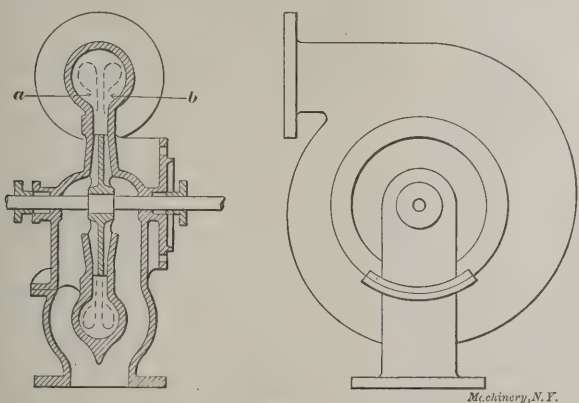


Fig. 4. Centrifugal Pump—Type C.

If the bucket were made exactly and mathematically correct we ought to have a different curve of vane for every change of speed and lift, but for manufacturing purposes it would involve so great a number of patterns as to be impracticable, and a compromise has to be made. In the diagram, Fig. 8, is given a simple method of striking the curve of the vanes which works very well, both for open and closed buckets up to large diameters, and which is in effective operation for lifts of 60 feet and over with best results. The method of laying out is as follows: Divide the circle representing the diameter of the bucket into six or any number of arms desired, bisect each radii, then using this bisected point as a center, and with a radius $BC = AB + 1/6$ of AB, draw the curves which represent the working face of the vanes of the bucket. The back of each vane can be made to give a thickness suitable to the material of which the bucket is to be made. Different firms have different methods, but this is simple and easily understood by any workman who has to make the pattern, and is very effective.

As an argument against the open bucket is the statement that it is possible to make the closed bucket a better fit between the facings than the open one, and thus there must be more leakage in the latter bucket than in the other; but this is not so, as they can both be made with the same clearance to begin with, and there is no more wear in one case than in the other. As far as the centrifugal effort is concerned, there is not any great difference between them, the slip in both being about the same. In some cases in the closed type—in order to reduce the leakage—one, two, or three facings are employed, with extra vanes on the outside to give a pressure between the facings; but additional facings are not a satisfactory solution of the difficulty. Another way has been to put loose rings in recesses in the casing, and keep them close up to the bucket by screws adjustable from the outside.

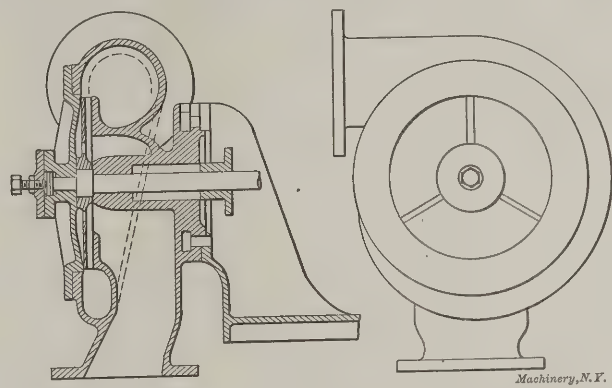


Fig. 5. Centrifugal Pump—Type D.

Pump Casings.

In Type A, which is the cheapest type of pump made, there is no attempt to reduce the velocity of the water leaving the bucket by means of an expanding chamber; and in many pumps the water emerges from the buckets only while passing the aperture of the outlet, so that, practically, the delivery from the bucket is intermittent, each section delivering for about a quarter revolution, and doing nothing for the remainder. Of course, the efficiency is comparatively low, and as it is only made in the smaller sizes and for low lifts, we need not waste any further time considering it. In Fig. 2, however, the conditions are more correctly allowed for, and it will be as economical as the other types, the flow of water from the bucket being similar to that in Type C.

In Type B, as the expanding chamber is formed partly around the outer circumference and partly between the sides of the bucket and the casing, and as the distance from the circumference of the bucket to the casing is comparatively short, the stream of water emerging from the bucket has to make a more or less sharp turn, as shown by dotted lines in the section, Fig. 3, to pass to the space on each side of the bucket.

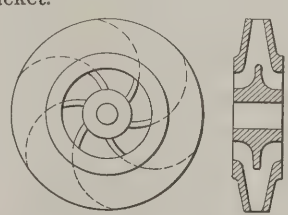


Fig. 6. Closed Type Bucket.

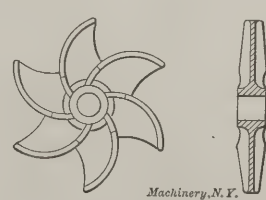


Fig. 7. Open Type Bucket.

Considering Type C, we find that the bucket is generally the open one, and the entry of the casing of the double inlet or balanced type. Referring to Fig. 4, the water in this case leaves the bucket and enters the expanding chamber in practically a circular plate of water of a width equal to the width of the periphery of the bucket, and moving radially or nearly so. As a rule this type of pump has the section of the expanding chamber circular and of increasing diameter, with practically sharp corners or of very small radius where the short, approximately parallel, passage known as the whirlpool chamber, from the pump bucket to the expanding cham-

ber, joins it. The dotted lines in Fig. 4 show the movement or the tendency of the movement of the water as it enters the expanding chamber. The natural tendency of the parallel moving sheet of water is to keep on in a straight line, and as it loses its velocity it spreads out and follows the path shown in dotted lines. This movement is modified to a certain extent by the water already in the chamber, moving toward the discharge. Attention to this movement of the water was first drawn from traces of deposits having been found in some casings at points *a* and *b*.

In Type D, Fig. 5, an attempt has been made to obviate some of these defects, and reduce the losses due to eddy. In this type it is noticed that the expansion chamber is formed, not in the center of discharge of the bucket, but to one side of it; the bucket is of the single inlet open type, tapered to the periphery to keep the velocity of the water constant. Referring to the section, Fig. 5, it will be noticed that as the water leaves the bucket it moves round the outside of the expanding chamber unbroken, and the water which has previously been discharged, and is moving toward the outlet, has a free passage through the middle of the chamber. The general result of this is that the water leaves the pump with a spiral movement of very long pitch. By using the single inlet there is no loss due to dividing the entering water. One bearing is provided close to the bucket, with another in the cover, both well protected from the water. Only one, and that the simplest form of joint, has to be broken to get at the bucket, and there is no difficulty whatever from end thrust with a properly designed bucket. The result of this type has been to get an increased efficiency of work, together with greater facility for examination. In every type of pump the casing should be provided with a stop which fits the bucket as closely as possible at the point marked *a* in Fig. 1 to cause the issuing water to move in one direction.

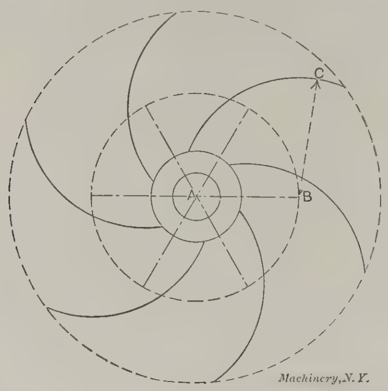


Fig. 8. Laying Out of the Vanes of the Bucket.

Compound Pumps.

In the compound or turbine pump we have the single centrifugal pump developed so as to obtain results which a single pump is not capable of, and results which at first sight would seem impossible to be obtained from a centrifugal pump at all. This has been accomplished by using two or more pumps working in series, that is with the delivery from the first passing to the second, the second to the third, and so on for as many series as are necessary for the head to be overcome. In compound pumps the conditions set up are somewhat different to those of the single pump. The guide plates for guiding the water on to the next bucket, so as to insure its moving in the right direction, are necessary, and these are fitted to all pumps, being arranged somewhat differently by each of the different makers.

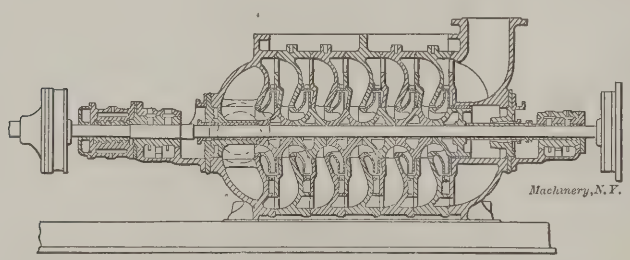


Fig. 9. Compound Centrifugal Pump.

It will be noticed in the sections of pumps given, that in Fig. 9 the closed bucket with single inlet is used, and is fitted with a balancing arrangement which is to balance the end thrust of successive buckets. Several makers have made their pumps with the buckets placed back to back, as in Fig. 10, to balance each other, but this necessitates more or less tortuous passages which should be avoided.

The compound pump may be roughly said to add a pressure for each successive stage equal to the pressure due to each stage if used as a single pump, that is, if with a single bucket pump one can get a pressure equivalent to 50 feet head, with two stages one would get 100, and with three stages 150 feet, and so on, and such pumps are made with 10 in the series, and up to very high lifts. The use of electric motors has given great impetus to the use of these high lift pumps and rendered possible their adoption where before they were impracticable, as driving these high lift pumps with either a belt or ropes is not at all a satisfactory way. With a compound pump one can also arrange to deliver a large quantity at a reduced pressure, or a small quantity at a higher pressure where the conditions require it, by running the buckets in parallel or in series.

In regard to efficiency of the compound pump, up to 75 and 80 per cent is claimed for it, except in very small sizes, and due to the fact that the delivery is constant and not intermittent, as with a reciprocating pump, the line of pipes can be made smaller for the same delivery, making a considerable saving in long lines of pipes, but the speed of flow should be considerably less than for single pumps. Also by driving them with motors they can be arranged to pump in stages, one compound delivering to the next stage, the second one receiving the delivery under a slight pressure, and so on for a considerable height, making them very suitable for deep mine pumping.

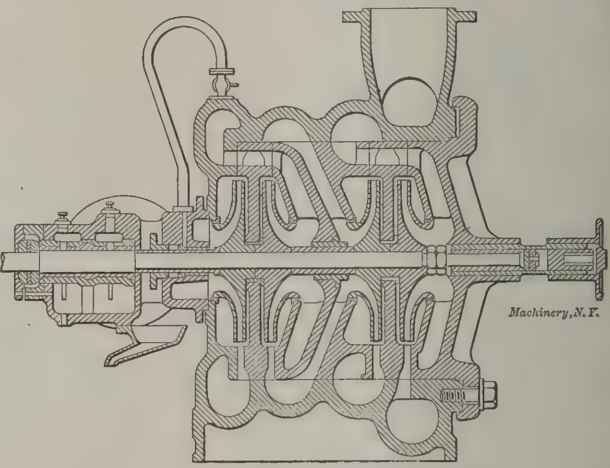


Fig. 10. Another Example of Compound Pump.

Losses of Energy.

In conclusion we may summarize the points where losses of energy in centrifugal pumps arise.

1. Friction of the water in the passages.
2. Loss of energy where water enters the bucket. This is practically a right-angle turn to the flow of the water, and unavoidable.
3. Loss of energy when water leaves the bucket and enters the expanding chamber.
4. Leakage at joint of bucket with casing.
5. Slip of bucket.
6. Friction of shaft in glands and bearings.

* * *

In this country we have made ourselves accustomed to look upon Hungary as being backward in all industrial progress. Recent reports, however, seem to indicate that this country is fairly well keeping pace with the progress in other parts of the world. The latest achievement in railroading in that country is the building of express locomotives for the government railroads of Hungary which will develop a speed of 85 miles an hour. In some other respects Hungary has also proven its ability to at least keep pace with the rest of us in industrial progress. It is claimed that the first subway in the world was constructed in Budapest.

* * *

The closing days of Congress were marked by an important amendment to the free alcohol bill which removes the present restrictions to small distillers, and makes it possible for farmers and others to establish small plants and produce denatured alcohol without a bonded warehouse. It undoubtedly will have an important influence on reducing the cost of denatured alcohol from the present price of 35 to 40 cents per gallon to a price that will make it an active competitor of gasoline and kerosene oil.

ON THE ART OF CUTTING METALS.—4.*

FRED. W. TAYLOR.

LIP AND CLEARANCE ANGLES OF TOOLS.

Contrary to the opinion of almost all novices in the art of cutting metals, the clearance angle and the back slope and side slope angles of a tool are by no means among the most important elements in the design of cutting tools, their effect for good or evil upon the cutting speed and even upon the pressure required to remove the chip being much less than is ordinarily attributed to them.

Clearance Angle of the Tool.

The following are our conclusions regarding the clearance angle of the tool:

(*a*) For standard shop tools to be ground by a trained grinder or on an automatic grinding machine, a clearance angle of 6 degrees should be used for all classes of roughing work.

(*b*) In shops in which each machinist grinds his own tools a clearance angle of from 9 degrees to 12 degrees should be used.

In seeking for the proper clearance angles for tools, we have as yet been unable to devise any type of experiment which would demonstrate in a clear cut manner which clearance angle is the best. The following, however, are the considerations which affect the choice of clearance angles.

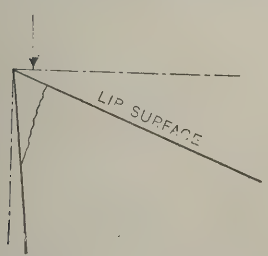


Fig. 28. Spalling of Tool-point by Downward Pressure of Chip.

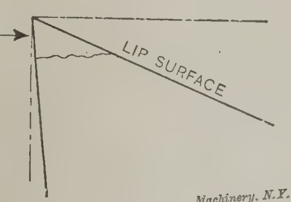


Fig. 29. Spalling of Tool-point by Pressure on Clearance Flank due to Feeding Tool into the Work.

On the one hand, it is evident that the larger the clearance angle, the greater will be the ease with which the tool can be fed (wedged or driven) into its work, the first action of the tool when brought into contact with the forging being that of forcing the line of the cutting edge into the material to be cut. On the other hand, every increase in the clearance angle takes off an equal amount from the lip angle, and therefore subjects the tool to a greater tendency to crumble or spall away at the cutting edge, as indicated in Figs. 28 and 29. It must be remembered also that the tool travels in a spiral path around the work, and that the angle of this path with a perpendicular line in the case of coarse feeds taken upon small diameters of work becomes of distinctly appreciable size. In all cases, therefore, the clearance angle adopted for standard shop tools must be sufficiently large to avoid all possibility from this source of rubbing the flank of the tool against the spiral flank of the forging. The clearance angles for roughing tools in common use vary between 4 degrees and 12 degrees. We have had experience on a large scale in different shops with tools carefully ground with clearance angles of 5 degrees, 6 degrees and 8 degrees. In the case of one large machine shop which had used clearance angles ground to 8 degrees through a term of years, they finally adopted the 6 degrees clearance angle with satisfaction. For many years past our experiments have all been made with the 6-degree clearance angle, and this has been demonstrated to be amply large for our various experiments. On the other hand, a 5-degree clearance angle in practical use in a large shop has appeared to us through long continued observation to grind away the flank of the tool just below the cutting edge rather more rapidly than the 6-degree angle. We have, therefore, adopted the 6-degree clearance angle as our standard.

It should be noted, however, that in shops systematized by us the cutting tools are invariably ground either on an automatic tool grinder, or by special men who are carefully taught the art of grinding and provided with suitable templets and gages, and that in this case the clearance angle for every tool is accurately made to 6 degrees.

In shops, however, in which each lathe or planer hand grinds his own tools, a larger clearance angle than 6 degrees should be used, say, an angle of from 9 degrees to 12 degrees, because in such shops, in nine cases out of ten, the workmen grind the clearance and lip angles of their tools without any gages, merely by looking at the tool and guessing at the proper angles; and much less harm will be done by grinding clearance angles considerably larger than 6 degrees than by getting them considerably smaller. It is for this reason that in most of the old style shops in which the details of shop practice are left to the judgment of the men or to the foreman, that clearance angles considerably larger than 6 degrees are generally adopted.

Lip Angle of the Tool.

The following are the conclusions arrived at regarding the angles at which tools should be ground:

A. For standard tools to be used in a machine shop for cutting metals of average quality: Tools for cutting cast iron and the harder steels, beginning with a low limit of hardness, of about carbon 0.45 per cent, say, with 100,000 pounds tensile strength and 18 per cent stretch, should be ground with a clearance angle of 6 degrees, back slope 8 degrees, and side slope 14 degrees, giving a lip angle of 68 degrees. These angles are used in the tool illustrated in Fig. 10, March issue.

B. For cutting steels softer than, say, carbon 0.45 per cent having about 100,000 pounds tensile strength and 18 per cent stretch, tools should be ground with a clearance angle of 6 degrees, back slope of 8 degrees, side slope of 22 degrees, giving a lip angle of 61 degrees. These angles are used in tool illustrated in Fig. 11, March issue.

C. For shops in which chilled iron is cut a lip angle of from 86 degrees to 90 degrees should be used.

D. In shops where work is mainly upon steel as hard or harder than tire steel, tools should be ground with a clearance angle of 6 degrees, back slope 5 degrees, side slope 9 degrees, giving a lip angle of 74 degrees.

E. In shops working mainly upon extremely soft steels, say, carbon 0.10 per cent to 0.15 per cent, it is probably economical to use tools with lip angles keener than 61 degrees.

F. The most important consideration in choosing the lip angle is to make it sufficiently blunt to avoid the danger of crumbling or spalling at the cutting edge.

G. Tools ground with a lip angle of about 54 degrees cut softer qualities of steel, and also cast iron, with the least pressure of the chip upon the tool. The pressure upon the tool, however, is not the most important consideration in selecting the lip angle.

H. In choosing between side slope and back slope in order to grind a sufficiently acute lip angle, the following considerations, given in the order of their importance, call for a steep side slope and are opposed to a steep back slope:

a. With side slope the tool can be ground many more times without weakening it.

b. The chip runs off sideways and does not strike the tool posts or clamps.

c. The pressure of the chip tends to deflect the tool to one side, and a steep side slope tends to correct this by bringing the resultant line of pressure within the base of the tool.

d. Easier to feed.

I. The following consideration calls for at least a certain amount of back slope. An absence of back slope tends to push the tool and the work apart, and therefore to cause a slightly irregular finish and a slight variation in the size of the work.

Before it is possible to discuss the proper lip angles for tools, two ways in which the cutting edge gives out should be described.

In Fig. 28 is shown on an enlarged scale the manner in which the sharp end of the wedge of the tool spalls off or crumbles away, when the lip surface of the tool right at the cutting edge is subjected to great pressure. In the case of cutting very hard metals and also in cutting all qualities of cast iron, the pressure of the chip is concentrated very close to the line of the cutting edge, and the harder the metal to be cut and the smaller its percentage of extension, the greater will be the concentration of the pressure close to this line, and the greater will be the tendency of the cutting edge to spall off or crumble away.

Fig. 29 shows another way in which the metal of the lip surface of the tool spalls off or crumbles away when the line of the cutting edge of the tool is subjected to great pressure in feeding or forcing the tool into the forging. In this case the hardness of the metal into which the tool is being fed

* Abstract of paper presented before the American Society of Mechanical Engineers, December, 1906.

is the chief element causing this type of injury to the cutting edge.

In deciding upon the acuteness of the lip angle of a tool, the absolute necessity of guarding against the spalling or crumbling of the cutting edge from both of the foregoing causes becomes by far the most important of all considerations. In this connection the essential fact to be borne in mind is that the harder the metal to be cut, the blunter must be the lip angle of the tool. In the case of chilled iron and semi-hardened steel, for instance, the lip angle must be made from 86 degrees to 90 degrees. A smaller angle than this will cause the metal at the extreme cutting edge to spall off or crumble away (quite as much on account of the feeding pressure as from the pressure of the chip), and thus ruin the tool. As the metal to be cut grows softer, however, the lip angle can be made keener without danger of spalling, until with standard tools intended to cut the softer steels, say with a high limit for hardness of about 100,000 pounds tensile strength and 14 per cent to 18 per cent stretch, the smallest lip angle which, in our judgment, it is on the whole wise to use would seem to be about 61 degrees.

Dr. Nicolson with his dynamometer experiments has shown that with a "cutting angle" of 60 degrees, corresponding to a lip angle of 54 degrees, clearance angle 6 degrees, tools re-

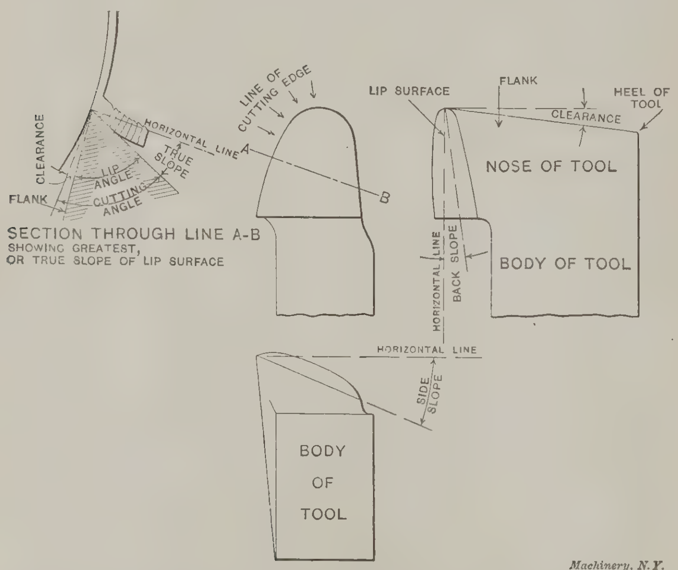


Fig. 30. Illustrating the Terms Body, Nose, Flank, Heel, Lip Surface, Clearance Angle, Back Slope, Side Slope, True Slope, Lip Angle, Cutting Angle, and Line of Cutting Edge.

move metal with the minimum of pressure. This is also corroborated in a general way by our observations in cutting dead soft steel. Therefore from the standpoint of pressure, with a view to taking the largest cut with a given pulling power and with the least strain upon the working parts of the lathe, this angle should be approached. And although, on the whole, the question of pressure on the tool has less weight than either the crumbling at the cutting edge, the cutting speed, or the proper angles for obtaining the longest life and the largest number of grindings for a given tool, still it must be considered; and it is this which has led us to choose for our standard in each case *the keenest cutting angle which is free from danger of spalling.*

Metals which even approach in hardness chilled iron and semi-hardened steel are but seldom met with in ordinary shop practice and, therefore, in selecting the lip angles for standard shop tools, we have divided the metals to be cut in a shop into two classes:

a. Cast iron and the harder classes of steel, say, beginning as a low limit for hardness with a steel of about 0.45 to 0.50 per cent carbon, 100,000 pounds tensile strength and 18 per cent stretch; and

b. The softer classes of steel.

Our guiding principle in selecting the lip angles for the tools to be used in cutting cast iron and the harder classes of steel has been to select what we believe to be the smallest or most acute lip angle which can be safely depended upon to run without danger of spalling off at the cutting edge while cutting the harder steels ordinarily met with in machine shop practice (such as the hardest steels used in this country for car wheel tires, say of 135,000 to 140,000 pounds tensile strength, and 9 to 10 per cent of stretch, and, for instance, unannealed tool steels, or the harder of the oil hardened and annealed forgings which are used under government specifications for making large steel cannon, etc.); and after large experience in cutting metals of this quality we have concluded that it would be unsafe to use a more acute lip angle than that shown in Fig. 10, namely, a lip angle of 68 degrees, with clearance angle of 6 degrees, side slope of 14 degrees and back slope of 8 degrees. We have demonstrated by repeated trials that tools with the above lip angle are safe from danger of spalling or of crumbling at the cutting edge, even when cutting tire steel, gun steel or tool steel.

For shops which are engaged mainly in cutting steels as hard as tire steel, we should recommend as a standard tool one having 6 degrees clearance, 5 degrees back slope and 9 degrees side slope, giving a lip angle of 74 degrees. Since for this special work the tools can be run at a high cutting speed, they can be ground in less time, and they can be ground more times for each dressing in the smith shop, than tools with more acute lip angles.

Repeated trials were made with tools ground first with a clearance angle of 6 degrees, back slope of 5 degrees, and side slope of 9 degrees, giving a lip angle of 74 degrees, and afterwards with a clearance angle of 6 degrees, back slope of 8 degrees, and side slope of 14 degrees, giving a lip angle of 68 degrees. No difference was indicated in the cutting speed of these two tools when used upon a very hard forging.

It is interesting, however, to note that machinists who grind their own tools and who are accustomed to machining hard tires and metals of the classes above referred to, invariably use a blunter lip angle than our standard of 68 degress. After making a few mistakes by grinding tools with lip angles which are too acute, they are sure to lean too far toward the safe side, and adopt lip angles which are not quite sharp enough. They are influenced in this very largely, however, by the fact that the less acute the lip angle, the easier it is and the less time it requires to grind a tool. A tool with a lip angle of 80 degrees for example, can be more easily ground than one with a lip angle of 70 degrees.

In those shops which work upon metals of average hardness and in which the tools are furnished to the machinists ground to the required shapes, and in which either automatic tool grinders are used or special grindstone men are employed to grind the tools, more work can be gotten out by grinding the tools to angles at least closely approximating ours than from the use of tools with blunter lip angles.

The reason for preferring the more acute lip angle of 68 degrees, for cutting medium hard metals to the angle of 75 degrees to 85 degrees adopted by the average machinist, is that the more acute angle removes the metal with a lower pressure on the tool; while repeated experiments made by us in cutting medium hard steels indicate that there is little if any difference in cutting speed between the 68-degree lip angle and coarser angles. Our standard tools, therefore, are capable of taking heavier cuts than the blunter tools, and in a given machine working to the limit of its pulling power, can remove rather more metal in a given time.

FORGING AND GRINDING TOOLS.

On the Shape of Tools as Affected by Grinding and Forging.

The following are the important conclusions arrived at upon this subject:

A. The shapes into which tools are dressed and the ordinary methods of dressing them are highly uneconomical, mainly because they can be ground only a few times before requiring redressing.

B. The tool steel from which the tool is to be forged should be one and one-half times as deep as it is wide.

C. To avoid the tendency of the tool to upset in the tool post under pressure of the cut, the cutting edge and the nose of the tool should be set well over to one side of the tool.

D. Tool builders should design lathes, boring mills, etc., with their tool-posts set down lower than is customary below the center of the work.

E. In choosing the shape for dressing a tool, that shape should be given the preference in which the largest amount of work can be done for the smallest combined cost of forging and grinding.

F. Forging is much more expensive than grinding; therefore the tool should be designed so that it can be ground:

a. The greatest number of times with a single dressing; and

b. With the smallest cost each time it is ground.

G. Best method of dressing a tool is to turn its end up high above the body of the tool. Tools can be entirely dressed by this means in two heats.

H. Importance of carefully heating the tool for dressing.

J. Fire or heat cracks in tools are due to the following causes:

a. Seams or internal cracks in bar of tool steel.

b. Nicking and breaking the bar of tool steel while it is cold.

c. Failing to turn the tool over and over while heating it for forging.

d. Too rapid heating, particularly at the start, in a hot fire.

K. It is of great importance to properly adjust the relative amount of work to be done in the smith shop and on the grinding machine in making the tool.

a. Too much work is generally done in dressing tools to exact shape in the smith shop, particularly when automatic grinding machines are used.

b. A limit gage should be used by the smith to properly regulate the proportion of smith work and grinding work in making the tool.

On Grinding Tools.

The following are the important conclusions arrived at with reference to grinding tools:

A. More tools are ruined in every machine shop *through overheating in grinding* than from any other cause.

B. The most important consideration is how to grind tools rapidly without overheating them.

C. To avoid overheating, a stream of water amounting to five gallons per minute should be thrown, preferably at a slow velocity, directly on the nose of the tool where it is in contact with the emery wheel.

D. To avoid overheating where tools are ground by hand or with an automatic tool grinder, the surface of the tool should never be allowed to fit closely against the surface of the grindstone. To prevent this, tools should be constantly moved or wobbled about during the operation of grinding.

E. To lessen the danger of overheating on the emery wheel and to promote rapid grinding, tools should be dressed so as to leave the smith shop with a clearance angle of about 20 degrees, while 6 degrees only is needed for cutting.

F. Flat surfaces upon tools tend far more than curved surfaces to heat tools in grinding.

G. Tools with keen lip angles, (*i. e., steel side slopes*) are much more expensive to grind than blunt lip angles.

H. It is economical to use an automatic tool grinding machine even in a small shop.

J. There is little economy in an automatic grinder for any shop unless standard shapes have been adopted for tools, and a large supply of tools is kept always on hand in a first-class tool room so that tools of exactly the same shape can be ground in quite large batches or lots.

K. Corundum wheels made of a mixture of grit size No. 24 and size No. 30, are the most satisfactory for grinding ordinary shop tools.

L. In grinding flat surfaces skillful hand grinders invariably keep the tool wobbling about on the face of the grindstone in order to avoid heating.

On the Size and Proportion of the Body of the Tool.

Twenty-five years ago it was perhaps the more general practice in this country to make the cross-section of the body of lathe and planer tools square, and this practice still generally prevails in England and upon the Continent. In fact, in the report of the Manchester experiments, previously referred to, in which the tools of eight of the leading engineering establishments were placed in competition, all of the tools illustrated have square shanks. Mr. James M. Gledhill also, in his admirable paper, on "The Development and Use of High Speed Tool Steel," read before the Iron and Steel Institute in 1904, refers to tools with square shanks as being the standard in use in the works of Armstrong, Whitworth & Co. It may be said, however, that the more general practice in this country at the present time is to make the depth of the body of the tool considerably greater than its width.

In choosing the proportion of the height of the shank to its depth, the effect of two forces must be considered—the downward pressure upon the nose of the tool, due to cutting the chip; and the side pressure at right angles to the tool, due partly to the feeding resistance, and partly to the direction in which the chip moves across the lip surface.

Dr. Nicolson, in his experiments, has shown that in the great majority of cases the side pressure upon the tool does not exceed 20 per cent of the downward pressure; and that more frequently the side pressure is even a smaller percentage of the vertical pressure. On the other hand, tools when properly designed and properly placed in the tool-post are supported in the majority of cases almost directly beneath the cutting edge, thus directly resisting the downward pressure upon the tool, and placing it mainly under compression, and so greatly diminishing the heavy downward transverse bending and breaking strains. If, then, tools were always set in their most advantageous position in the tool-post, the practice of using steel of square cross-section might not be far wrong. However, in both lathe and planer work it is often necessary to set the tool with considerable overhang beyond the tool support, and in these instances it is evident that the depth of the tool should be considerably in excess of the width.

It is manifestly of great importance to have the tools as light as possible, consistent with their strength, for ease of handling in setting the tool in and removing it from its tool-post, and in grinding and dressing; and a much lighter tool of equal strength and stiffness can be used when the height exceeds the width than when the cross-section is square.

For the above reasons some of the large machine shops in this country have adopted a proportion of 2 in height to 1 in width for the cross-section of their standard tools. However, owing to the desirability of turning the noses of tools high above the top surface of the body of the tool for economy in grinding and dressing, and also owing to the design of the tool-posts of the greater part of the machines in this country, it is, in the judgment of the writer, unwise to adopt a height as great as 2 to 1 for the body of the tool. After practical trial on a large scale and close observation of several different proportions, we have adopted as standard the section of 1½ in height to 1 in width for the body of the tool.

Importance of Lowering Tool Supports in Designing Machine Tools.

We attach so much importance to raising the nose of the tool above its top surface and at the same time having the section of the body of the tool deeper than its width, that we would especially call the attention of machine tool builders to the desirability of designing their tool supports in lathes, boring mills, etc., further below the centers than is customary. When preparing for the best shop standards in reorganizing the management of machine shops, it has become our custom to systematically go over all of the machine tools and lower the tool rests to as great an extent as is practicable. Fortunately this in many cases entails but a small expense. However, in other cases it has been found desirable and economical to re-design the cross slides of many lathes so as to accomplish this object.

The Length of the Shanks of Cutting Tools.

In choosing the proper lengths for cutting tools, we again find two conflicting considerations:

A. It requires a certain very considerable length for the shank of each sized tool in order to fasten or clamp it in its tool-post. When the tool becomes shorter than this minimum, it must be thrown away, thus wasting costly metal, particularly in the case of the modern high-speed tools.

B. On the other hand, the longer the body of the tool, the more awkward and the slower become all of the operations in handling the tool, beginning with the dressing and followed by the grinding, storing, handling in the tool room, and setting and adjusting in the machine.

We know of no definite, clear cut method of comparing the relative loss in handling long and heavy tools with that of the waste of the tool steel, so that the adoption of standard lengths for dressing tools of various sizes has been largely a matter of "rule of thumb" judgment on our part, and the length of tools which we have adopted, corresponding to different sized bodies, is given in the table below.

Let width of shank of tool $= A$, and length of tool $= L$; then $L = 14A + 4$ inches.

Size of Shank of Tool, inches.	Length of Tool, inches.	Size of Shank of Tool, inches.	Length of Tool, inches.	Size of Shank of Tool, inches.	Length of Tool, inches.
½ x ¾	11	⅞ x 1⅜	16¼	1½ x 2¼	25
⅝ x 1	12¾	1 x 1½	18	1¾ x 2⅝	28½
¾ x 1¼	14½	1¼ x 1⅞	21½	2 x 3	32

VOLUME, PRESSURE AND HORSEPOWER OF BLOWER PERFORMANCE.

The following data, diagrams and tables (see supplement) compiled by the B. F. Sturtevant Co. appertain to the measurement of volume, pressure and horsepower of blowers at pressures 1 to 10 pounds per square inch. A table of diameters of cupola blast pipes for lengths 20 to 140 feet, and losses of ¼ and ½ ounce pressure per square inch is also included. The friction varies as the square of the velocity and inversely as the diameter of the pipe, therefore, if the diameter of the pipe is doubled the friction loss is divided by 32, provided, of course, the same volume is carried. The advisability of using a large pipe for conveying the air is clearly shown.

Velocity.—The volume of air discharged from an orifice or pipe is, theoretically, equal to the product of the velocity of the air flowing and the area of the orifice. Hence, for the calculation of volume, the velocity is an important factor. To determine the velocity, the Pitot tube is commonly used as shown in the accompanying illustration. It should be inserted in the center of a straight run of blast pipe within about ten feet of the blower. One part of the Pitot tube transmits the total pressure, which is the sum of the static pressure and the velocity pressure. The other part, in communication with the slots shown by dotted lines in Fig. 2, transmits the static pressure. Evidently the difference is the velocity pressure. Each is connected to a water gage which should show magnified readings so that the difference may be accurately determined.

Accuracy.—Great care should be exercised in measuring the velocity pressure, and the instruments should be carefully calibrated. In the ordinary blast pipe for conducting air from the blower to the cupola or furnace, the velocity should not exceed two or three thousand feet per minute. As this velocity corresponds to a pressure of only about 0.4 inch of water, the measurement requires care, but with good instruments the readings will be accurate enough for all practical purposes.

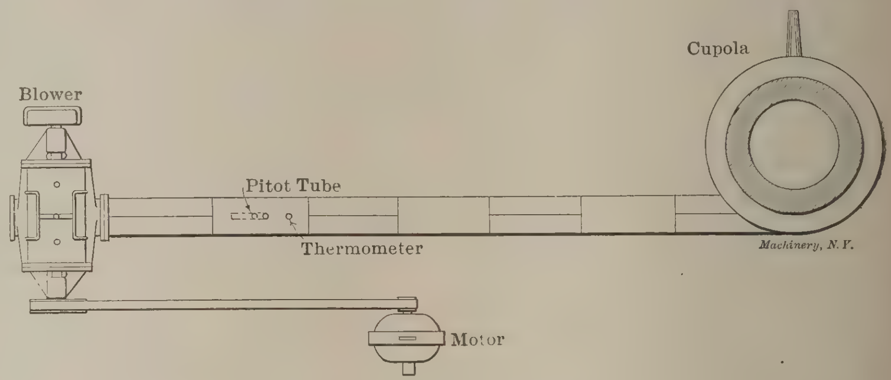


Fig. 1. Location of Pitot Tube in Blast Pipe.

DIAMETERS OF BLAST PIPES.

Tons of Iron per Hour	Inside Dia. of Cupola Inches	Cubic Ft of Air per Minute	20		40		60		80		100		120		140	
			¼ oz.	½ oz.	¼ oz.	½ oz.	¼ oz.	½ oz.	¼ oz.	½ oz.	¼ oz.	½ oz.	¼ oz.	½ oz.	¼ oz.	½ oz.
1	23	500	6	5	7	6	7	6	8	7	9	8	9	8	9	8
2	27	1,000	8	7	9	8	10	9	11	9	11	10	12	11	12	11
3	30	1,500	10	8	11	10	11	10	12	11	13	11	13	12	14	12
4	32	2,000	11	9	12	11	13	12	14	12	15	13	15	14	16	14
5	36	2,500	12	10	14	12	15	13	15	14	16	14	17	15	17	15
6	39	3,000	13	11	15	13	16	14	17	15	18	15	18	16	18	16
7	42	3,500	13	12	15	13	17	15	17	15	18	16	19	17	20	18
8	45	4,000	15	12	16	15	18	15	18	16	19	17	20	18	21	18
9	48	4,500	15	13	17	15	18	16	19	17	20	18	21	19	22	19
10	54	5,000	15	13	18	15	19	17	20	18	21	18	22	19	23	20
11	54	5,500	16	14	18	16	20	17	21	18	22	19	23	20	23	20
12	60	6,000	17	14	19	17	20	17	21	19	22	20	23	21	24	21
13	60	6,500	17	14	19	17	21	18	23	19	23	20	24	21	25	22
14	60	7,000	18	15	20	18	22	19	23	20	24	21	25	22	26	23
15	66	7,500	18	16	21	18	22	19	24	21	25	22	26	22	27	23
16	66	8,000	18	16	22	18	23	20	24	22	26	22	26	23	27	24
17	66	8,500	18	16	22	18	23	20	24	22	26	22	27	24	28	24
18	72	9,000	18	17	22	18	24	21	25	22	27	23	27	24	28	25
19	72	9,500	20	17	23	20	24	22	26	23	28	23	28	25	29	26
20	72	10,000	20	18	23	20	25	22	27	23	28	24	29	25	30	26
21	78	10,500	21	18	24	21	26	23	27	23	29	25	30	26	30	26
22	78	11,000	21	18	24	21	27	23	28	24	29	26	30	27	31	27
23	78	11,500	21	19	25	21	27	24	28	25	30	26	30	27	31	27
24	84	12.000	22	19	25	22	28	24	28	25	31	26	31	27	32	28
25	84	12,500	22	19	26	22	28	24	29	26	31	27	32	28	33	28
26	84	13 000	22	19	26	22	28	24	29	26	31	27	32	28	33	28
27	90	13,500	23	20	26	23	28	24	30	26	31	27	32	28	34	28
28	90	14,000	23	20	27	23	29	25	30	27	32	28	33	29	34	29
29	90	14,500	23	20	27	23	29	26	31	27	32	28	33	29	34	30
30	90	15,000	24	21	27	24	29	26	31	27	32	28	34	30	35	30

(Length of Pipe in Feet: 20–140; Diameter of Pipe with Drop of ¼ oz. / ½ oz.)

The minimum radius of each turn should be equal to the diameter of the pipe. For each turn thus made add three feet in length, when using this table. If the turns are of less radius, the length added should be increased proportionately.

Volume.—The velocity pressure being known, the volume of free air passing through the pipe may be determined from the following formula:

$$V = a\,v = \frac{60\,a\,c\,P_1}{P}\sqrt{\frac{2gp}{d}}$$

in which $V =$ the volume of free air in cubic feet per minute,

$c =$ coefficient of Pitot tube, which should be determined for each tube,

$a =$ area of the pipe in square feet,

$v =$ velocity in feet per minute,

$2g = 64.32$,

$p =$ velocity pressure in pounds per square foot; p is the difference between the two pressures observed on the Pitot tube.

$d =$ density or weight per cubic foot of air at pressure, temperature and humidity at point of observation,

$P_1 =$ absolute pressure of air in the pipe in pounds per square foot,

$P =$ atmospheric pressure in pounds per square foot.

Horsepower.—Assuming that the air is compressed without cooling, the horsepower may be found from the following:

$$H.P. = \frac{V\,P\left[\left(\frac{P_1}{P}\right)^{\frac{1}{3}} - 1\right]}{11,000}$$

in which

$V =$ volume of free air in cubic feet per minute, as found above,

$P =$ pressure of the atmosphere or suction pressure (absolute) in pounds per square foot,

$P_1 =$ pressure of compression (absolute) in pounds per square foot.

There are, however, including the preceding one, four formulas which may be used in computing the horsepower required. These are given in the supplement.

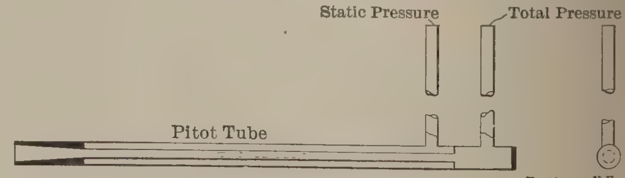


Fig. 2. Construction of Pitot Tubes.

The formula No. 1 is used when the air is cooled during compression, as in ordinary air compressors; No. 2 when it may be assumed that the air is compressed so quickly that it does not have time to cool to atmospheric temperature; No. 3 is the ordinary "hydraulic" formula, and No. 4 is used for positive or rotary blowers.

PNEUMATIC CLAMP DRILLING JIG.

O. C. BORNHOLT.

The accompanying line cuts, Figs. 1 and 4, and the halftones, Figs. 2 and 3, show a pneumatic clamp drilling jig which was designed for holding small castings, pinions, spur gears, sprockets, pulleys, etc., for reaming or drilling. This type of jig is used with great success in one of the largest manufacturing concerns in Chicago. Formerly castings of the nature named were held in a jig, using a screw bushing mounted in a swinging arm to hold the work while drilling; the arm was swung around over the casting and the bushing was screwed down onto the work. Frequently the operator would neglect to screw the bushing down tightly against the work, with the resultant of a bad job of drilling and a spoiled piece. In any case there was considerable time lost in operating the jig.

The air clamping drilling jig shown in section in Fig. 1 was designed to decrease the time required to operate the jig and to improve the character of the work done. The cut shows how a bevel gear is held. The gear rests on the inclined face *C*, and between three chuck jaws. Beneath the casting is a ring, *A*, having three cam eccentric slots which move the jaws *B* toward or away from the center when the

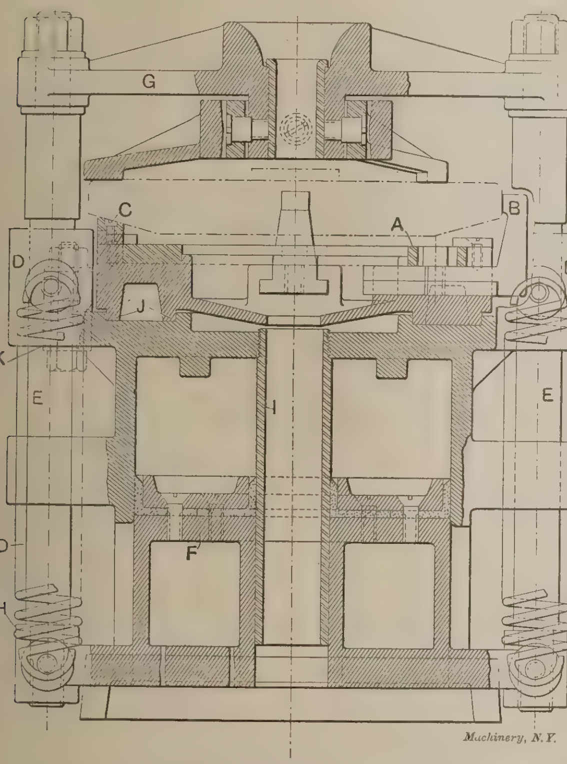


Fig. 1. Vertical Section, Pneumatic Clamping Jig for Work on Agricultural Machinery.

ring is turned by a suitable handle. With this jig the operator needs only to turn an air valve handle to hold the work securely and in the central position. To hold spur gears a centering piece is used, similar to the one shown for bevel gears in Fig. 1, with the exception that the surface *C* is made flat, the jaws then being used alone to center the work.

The jig includes a cylinder having two lugs or ears *D* which encircle the guides *E*. These guides connect the piston *F* with the cross-arm or yoke *G*, which holds the drill bushing. The admission of air to the cylinder forces the yoke and bushing down on the work and holds it there until the piece is finished. The air is then released and the tension springs *H*, of which four are provided, pull the piston and connected cross-arm up and release the work. Compressed air is admitted in the side of the cylinder through a pipe in which is fitted an ordinary three-way valve. The pipe *I* in the center of the cylinder is an important feature, as it permits chips to fall through the jig at the bottom instead of collecting on the top. What few chips accumulate on the top are removed by a hose leading from the exhaust port of the valve and directed against the top of the cylinder, thereby blowing the chips away with each exhaust. The centering device is made different, of course, for different pieces, Fig. 1 showing one for a "flat" bevel gear, and each pattern of pinion, gear or sprocket has to have a corresponding piece *C*. The cylinder has an annular groove *J* turned in the top and made concentric with the axis of the cylinder and of the drill jig. The centering device has two projections which fit the cylinder top

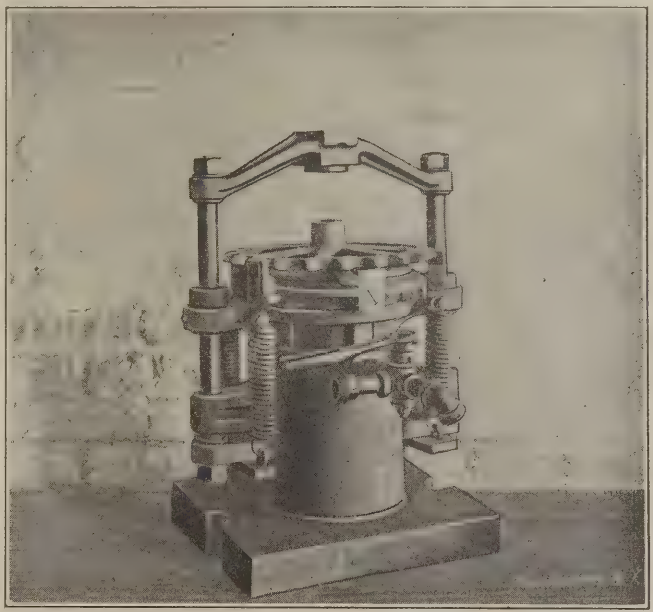


Fig. 2. Pneumatic Clamping Jig for Sprocket Wheel.

and groove. This makes the air cylinder conveniently interchangeable with any number of centering devices, the centering device being removed quickly so that there is little time lost in making changes, the clamping being a simple matter. The cylinder has three lugs *K* with open slots for bolts, these matching with three lugs on the centering device and constituting the clamping arrangement for the centering piece. When the centering piece is to be changed the three bolts are loosened, slipped out of the slots, and the centering piece is lifted out and exchanged for another.

If the drill bushing has to be changed, the yoke *G* is taken off and replaced by another, for it is generally desirable to have a yoke with its own bushing for each job. With small work the yoke simply has a bushing driven from the bottom,

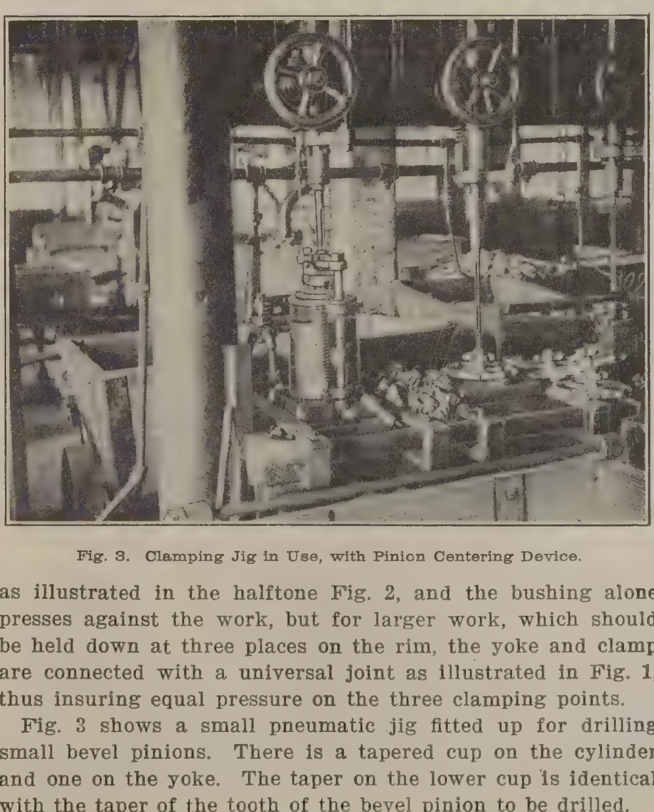


Fig. 3. Clamping Jig in Use, with Pinion Centering Device.

as illustrated in the halftone Fig. 2, and the bushing alone presses against the work, but for larger work, which should be held down at three places on the rim, the yoke and clamp are connected with a universal joint as illustrated in Fig. 1, thus insuring equal pressure on the three clamping points.

Fig. 3 shows a small pneumatic jig fitted up for drilling small bevel pinions. There is a tapered cup on the cylinder and one on the yoke. The taper on the lower cup is identical with the taper of the tooth of the bevel pinion to be drilled.

Fig. 4 is a centering device, used on the air cylinder, in which there is a float. This float rests on a heavy spring and on the float are three lugs *A* which support the gear casting. This device centers the casting while the yoke is pulled down by air pressure until the gear rests on the three stationary surfaces *B*. The yoke with its equalizing saddle *C* holds the bevel gear firmly while drilling.

GRINDING A LARGE CRANKSHAFT.

J. C. SPENCE.

A prominent English chainmaker recently sent to the Norton Grinding Co., Worcester, Mass., a rough-turned crankshaft to be ground to the dimensions given in Fig. 1. The conditions given were that the throw must be ½ inch plus or minus 0.001 inch and that the keyway shown in Fig. 1 should line up exactly with the highest point of the eccentric. The keyway was already in the shaft, when received. The following method was pursued in preparing the crankshaft for the grinder:

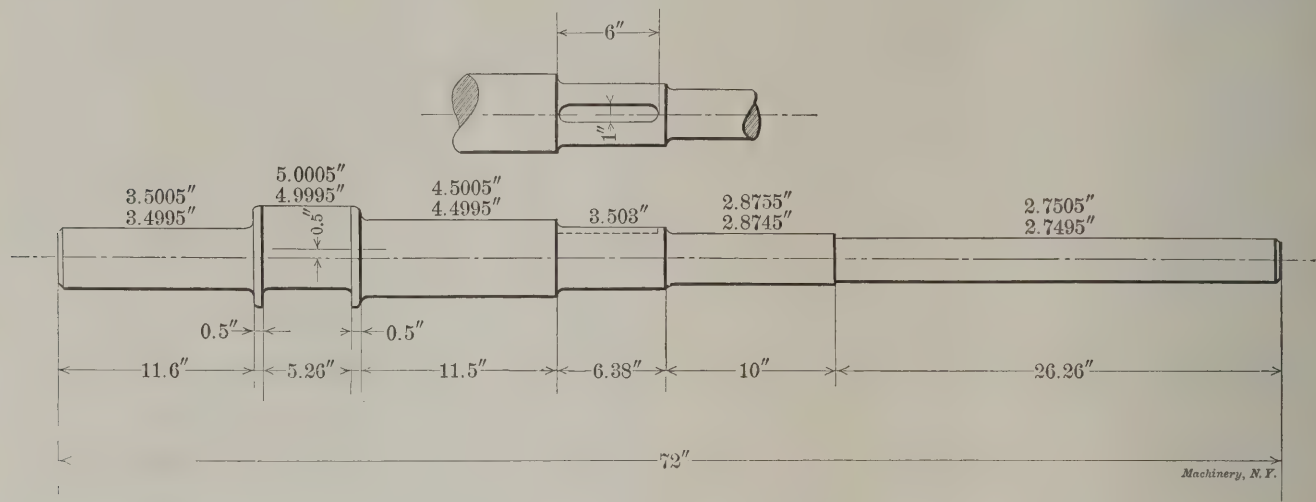


Fig. 1. Crankshaft to be Ground.

Two cast iron blocks, Fig. 2, were planed to the dimensions given and one side, *E* in Fig. 3, was scraped to a surface-plate. A squaring chip was then taken across a lathe face-plate and the plate was rigged with blocks and parallels as per Fig. 3. The surface *E* of the parallel *B* was also scraped to a surface-plate.

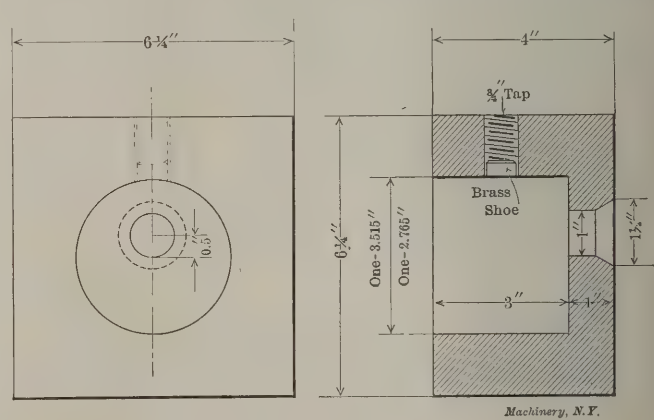


Fig. 2. Fixture for Grinding Crankshaft.

When the large hole was bored, the block *A*, Fig. 3, was against parallel *C* and when the small hole, or eccentric hole, was bored, *A* was moved along parallel *B* and block *D* was inserted. Tissue paper was used in both settings to insure actual contact.

The large holes were bored 0.015 inch larger than the finished diameter of the crankshaft ends. After boring the small holes, a 1-inch arbor was forced into the small holes and the 60-degree center holes were turned with a lathe tool. The truth of these 60-degree holes was tested by means of a ground cone point and red lead. A tapped hole and setscrew completed each block.

The shaft was now prepared for the blocks by grinding each end a wringing fit for its block. Before doing this, the center holes in the shaft were tested and scraped to a 60-degree cone point, to insure a perfectly round shaft when ground.

The next operation was to correctly locate the keyway. For this, two blocks, *A* and *B*, Fig. 4, were made. *A* is a 1-inch block that tapped lightly into the keyway and projected a short distance, as shown. *B* is a block planed to micrometer

ALCOHOL AND CALCIUM CARBIDE CARBURETER.

An alcohol and calcium carbide carbureter was the subject of an interesting demonstration made by Joseph Tracy in New York recently, its object being to demonstrate the possibilities of a new fuel mixture for gas engines having denatured alcohol and acetylene gases as its components. Mr. Tracy is a racing automobilist of considerable reputation and is greatly interested in the future of denatured alcohol. He made a trip from New York to Philadelphia January 1 in an automobile equipped with an ordinary gasoline engine, using denatured alcohol as the fuel. The experience of this trip demonstrated that while alcohol could be used in ordinary gasoline engines it had some drawbacks that made changes necessary. The subject of the demonstration was an engine fitted with a special carbureter in which a small quantity of calcium carbide is placed and is wetted with a mixture of alcohol and water in the proportion of one-sixth water to five-sixths pure alcohol. The alcohol is thus drawn through a bed of calcium carbide producing a mixture of alcohol and acetylene gas which has been named "alkoethine." The advantage claimed for the mixture is that it increases the rapidity of action, producing about the same result as gasoline but at a lower cost. It is asserted that the combination of the alcohol and acetylene gases makes a fuel that partakes of both the merits of alcohol and acetylene gases and at a cheaper price than is possible with gasoline or denatured alcohol alone.

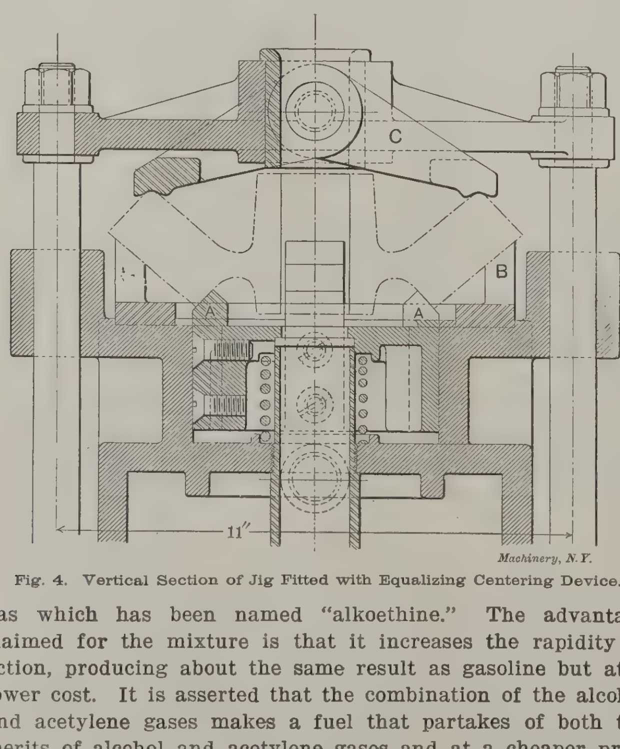


Fig. 4. Vertical Section of Jig Fitted with Equalizing Centering Device.

gage, and of such a height as to bring the center line of the keyway and the center line of the crankshaft into a plane parallel to the planer surface *C*, Fig. 4. The proper height of *B* was easily found by means of micrometer measurements and deductions.

Having made *A* and *B*, Fig. 4, the whole job was taken to a newly planed planer table and the end blocks were placed on the crankshaft. *A* was then placed in the keyway and the crankshaft turned until *A* rested on *B*. With tissue paper

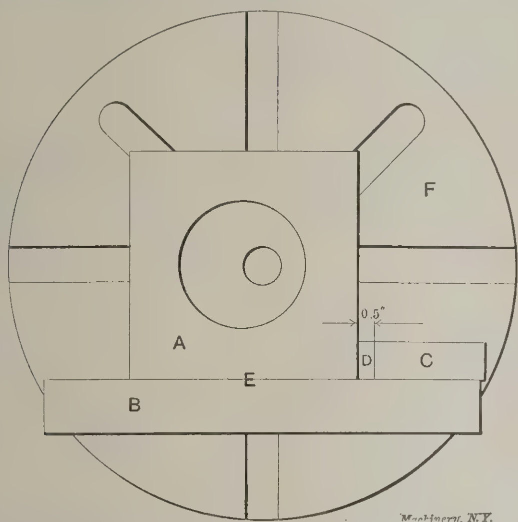


Fig. 3. Method of Boring Fixture for Grinding Crankshaft.

under the end blocks *D*, Fig. 4, and between *A* and *B*, adjustments were made until all the papers held fast. The blocks *D* were then made secure by means of the setscrews *E*. After a final test with the tissue papers, the crankshaft was ready to have the eccentric ground. This was done on an 18-inch by 96-inch Norton plain grinder. The fillets on the eccentric were also ground at the same time.

CAM CURVES.

ARTHUR B. BABBITT.

When the curve of a cam is not determined by a given definite motion of the follower, and the condition presented to the designer is simply to make the follower move through a given distance during a given angle of motion of the camshaft, the ease and silence with which the cam works depends upon the character of curve used in laying out the advance and return. The uniform motion curve, the simplest of all curves to lay out, is a hard-working curve, and one that can-

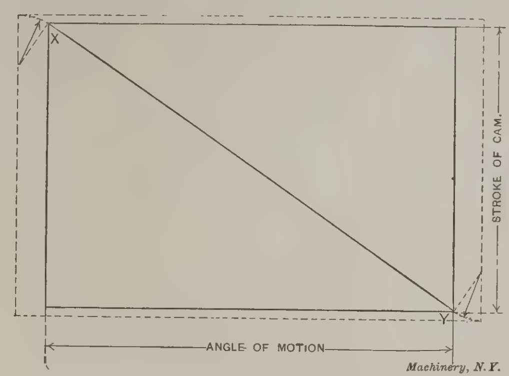


Fig. 1. Uniform Motion Curve.

not be run at any great speed without a perceptible shock at the beginning and end of the stroke.

The uniform motion curve would be represented in a diagram by the diagonal of the rectangle of which the base represents the angle of motion, and the altitude, the stroke of the cam, as shown by the full lines in Fig. 1. However, should the nature of the design demand a uniform motion for a given part of the revolution of the camshaft, the shock at beginning and end of stroke may be modified by increasing both the angle of motion and the stroke, and, in the diagram,

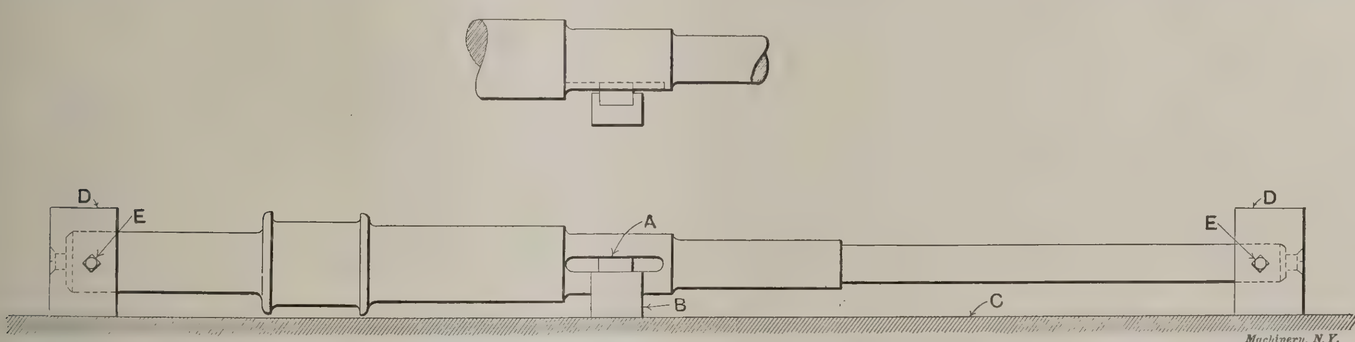


Fig. 4. Method of Mounting Crankshaft in Fixture.

The length of throw was tested in the grinder by means of a Bath indicator and a 1-inch B. & S. disk, and found to be within the required limits.

When the eccentric was completed, the end blocks were removed and the remainder of the crankshaft was ground on its own centers.

* * *

According to the *Iron Age* a new tunnel is to be built through the Bernese Alps for a railroad to connect at Brigue with the Simplon tunnel route. The new road will be 35 miles long and the tunnel 8.39 miles. The road will be operated by electricity, and have a maximum gradient of 0.27 per cent. This road will be the shortest route between Milan and Genoa and the north and northwest of Switzerland. It will shorten the approach to the Simplon tunnel, and will compete with the St. Gotthard tunnel route. The distance between the Italian cities mentioned and Paris will in fact be 15 miles shorter than at present, and 100 miles nearer than by the St. Gotthard tunnel. The new road is expected to be of great value to central Switzerland, particularly to the canton and city of Berne. Work on the tunnel is to be commenced at once, and the approaches and connections will be completed later, when progress on the tunnel boring is sufficiently far advanced to require it. This will be the fourth Alpine tunnel exceeding 8 miles in length.

filling in arcs of circles as shown by the dotted lines in Fig. 1. The amount of curvature at the ends of stroke is dependent upon the amount it is possible to increase the angle of motion, and the centers of the arcs are determined by drawing perpendiculars to XY as shown in Fig. 1. It will be noticed that the uniform motion has been maintained for the original angle, the modifications at the ends causing the increase of angle of motion and of stroke, the rectangle formed by these two being shown by dotted lines. Even with these modifications the cam is still apt to work hard, especially if the angle of motion is small.

The crank or harmonic motion curve works much more easily than the uniform curve, and a cam laid out with this motion may be run at a high speed without much shock or noise. To draw a diagram of this curve, draw a semi-circle having a diameter equal to the stroke of the cam, and divide this semi-circle and the line representing the angle of motion into the same number of equal parts. The intersection of lines drawn from these divisions will give points on the curve. Fig. 2 shows the harmonic curve and the manner in which it is obtained.

Probably the easiest working cam curve is the one known as the gravity curve. This curve has a constant acceleration or retardation bearing the same ratio to the speed as the acceleration or retardation produced by gravity; hence its

name. A body falling from rest will pass through about sixteen feet in one second (more accurately 16.09 feet). During the next second the body will increase its velocity by about thirty-two feet, making the distance covered during the second second forty-eight feet; during each succeeding second the body will gain in velocity thirty-two feet. Using sixteen feet as a unit of measurement, it will be seen that a body would travel through units 1, 3, 5, 7, 9, etc., during successive seconds or units of time. To apply this motion to the cam curve we might divide the angle of motion into a given number of equal parts and, using the units given above, we may increase the velocity to a given maximum and then, retarding with the same ratio, bring the follower again to rest at the other end of the stroke. In the diagram, Fig. 3, the line representing the angle of motion is divided into eleven equal parts which necessitates eleven divisions on the line representing the stroke of the cam. If the motion for the first part of the stroke is to have a constant acceleration, as referred to above, the distance traversed by the follower during the first

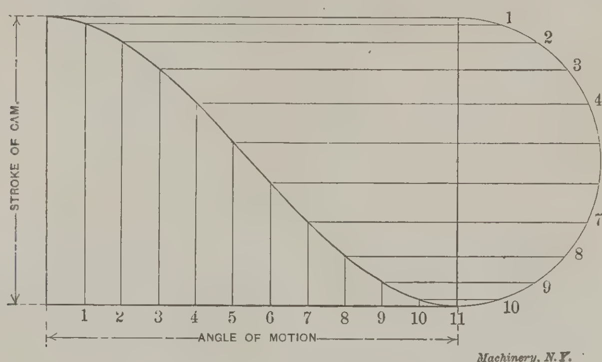


Fig. 2. Crank or Harmonic Motion Curve.

part of the angle of motion would be one unit; in the second part, three units; in the third part, five units, and so on until the maximum velocity has been reached, which would

Number of Period.	Distance Traversed by Follower during one Period.	Total Distance Traversed since beginning of Motion.
1	1	1
2	3	4
3	5	9
4	7	16
5	9	25
6	11	36
7	9	45
8	7	52
9	5	57
10	3	60
11	1	61

be during the sixth part of the angle of motion when the follower would travel through eleven units of motion. At this point the motion would begin to be retarded by a constant deduction which would cause the follower to move through nine units during the seventh interval of time, seven units

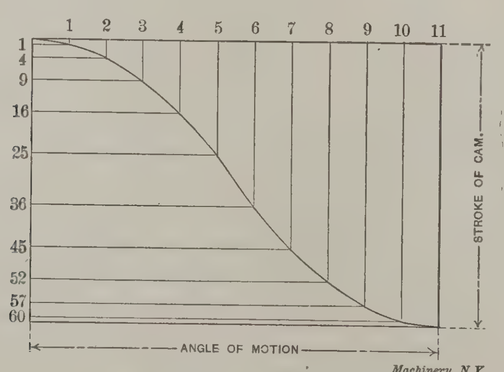


Fig. 3. Gravity Motion Curve.

during the eighth, five units during the ninth, three units during the tenth, and one unit during the eleventh and last interval. The sum of these units is sixty-one, which will necessitate dividing the line representing the stroke of the cam into sixty-one equal parts of which the first, fourth, ninth, sixteenth, twenty-fifth, thirty-sixth, forty-fifth, fifty-second, fifty-seventh, sixtieth and sixty-first will be used for determining points on the curve. The combination of the table given and the diagram shown in Fig. 3 will show how the gravity curve may be drawn.

A very close and satisfactory approximation for the gravity curve, and one that entails less work than the theoretical, is shown in Fig. 4. The method of drawing is similar to the one used for the harmonic motion, excepting that an ellipse takes the place of the semi-circle. It can be seen very readily that the ratio of the major and minor axes will determine the

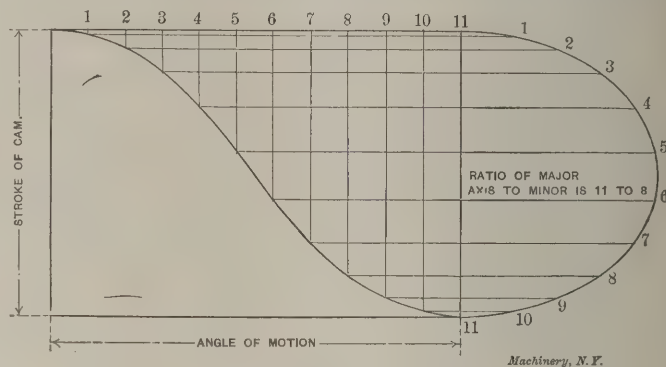


Fig. 4. Approximate Gravity Curve.

character of the cam curve. To obtain a curve that will approximate the gravity curve, the line representing the stroke of the cam should be used as the minor axis and the ratio of major axis to minor axis should be 1⅜ to 1 or 11 to 8. Dividing the semi-ellipse and line of angle of motion into the same number of equal parts, and projecting, we obtain points

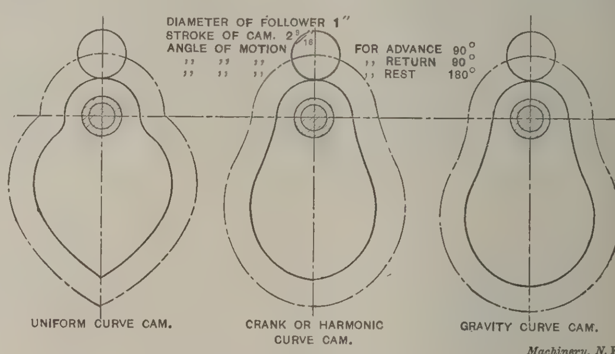


Fig. 5. Comparison between the Different Cam Constructions.

on the curve. Fig. 5 is given so that a comparison may be made of the three motions given above when applied to the same cam.

* * *

The daily newspapers have had a glorious time telling about the wonderful scheme of the Bethlehem Steel Co. offering to teach 3,000 apprentices the secrets of steel making. It is said that Mr. Schwab has evolved a scheme whereby opportunity would be given to 3,000 boys to enter the Bethlehem mills where they would be trained to become not only mechanics, "but experts with a full knowledge of the highest development of the iron and steel business." While we gladly recognize the enormous increase in this line of activity, we still fail to comprehend what the country would do with 3,000 experts with a "full knowledge of the highest developments, etc.," nor can we see that there would be any inducement for Mr. Schwab to undertake to train 3,000 boys with this object in view. It is pertinent to assume, however, that it is workmen and not experts Mr. Schwab is looking for, particularly when we find that there will be no formality in entering the service. Those who wish to start work are simply asked to present themselves at the gates of the mills. Even the machine tool builder, who does not claim that he intends to make an expert of every apprentice, is, we are glad to say, a little more discriminating in regard to the boys started on the road of mechanical success.

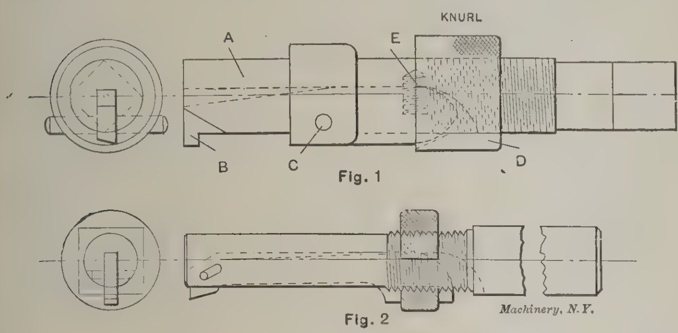
* * *

Judging the size of a port from the tonnage entering it, London is at the present time the greatest port in the world, the tonnage for 1905 being more than 17,000,000 tons. The second place is occupied by New York, and the third by Liverpool.

LETTERS UPON PRACTICAL SUBJECTS.

EXPANDING TOOLS.

Numerous adjustable and expanding tools of different kinds and designs, that are made by manufacturing concerns, supply the general need for such shop accessories. While plenty of shops keep a good stock of almost every such tool on the market, special tools are always more or less necessary. The accompanying sketches show a few such tools that have given excellent service and proven generally satisfactory.



Figs. 1 and 2. Recessing and Slotting Tools.

Fig. 1 shows a tool which is intended for recessing, grooving and chambering; *A* is a bar which may have a taper shank or a straight shank squared for a wrench. The lever or tilting cutter *B* is fitted into a slot in the bar and hinges on pin *C*. The cutter *B* is moved or fed at the cutting point (which may be of the size or shape required) by feed nut *D*, which should have a left-hand thread. This allows the tool to be fed while running right hand by slightly gripping the

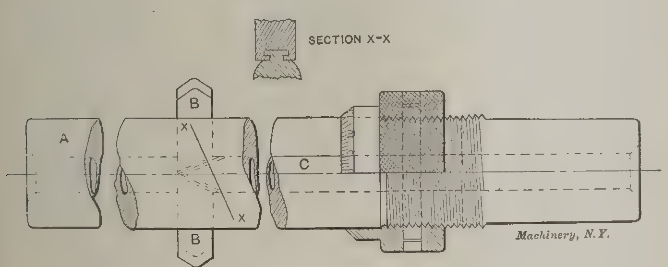


Fig. 3. Boring Bar with Double Cutters.

nut occasionally. This tool is especially useful in recessing and underscoring and preparing holes that are to be tapped a certain depth, or to the bottom. It is well adapted to drill-press work. The cutter is pressed back by spring *E* when the feed nut is run back. This tool works well on any diameter, 5/16 inch and larger.

Fig. 2 shows a slotting tool for cutting keyways in small work, the long, slender ones in long holes that are generally

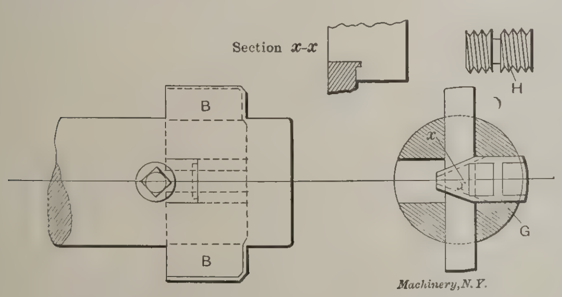


Fig. 4. Expanding Tool for Counterboring and Reaming.

so disagreeable. This tool gives splendid service in holes ¼ inch diameter and larger and may be conveniently used in the shaper by having the shank bent at a right angle. Fig. 3 shows a boring bar with double cutters, although single may be used if desired. Cutters *B* are fitted into a square hole in bar *A* and are fed out by rod *C*, which is provided with a micrometer adjustment, the latter graduated to read to 0.001 inch. This bar is well adapted to vertical or horizontal boring machines or lathe work for boring, chambering, recessing and general work of such character that the cutter is not accessible, but must be fed out or adjusted by some means extending beyond the portion of the bar covered by the work being bored. The cutters are easily removed by running the feed rod back until the dove-tails are disengaged. Fig. 4 shows an adjustable cutter which can be used for general purposes and is well adapted to work where the cutter is to be used near the end of the bar, such as vertical boring and chucking machines, car-wheel boring, etc. Cutters *B* are moved by the dove-tail wedge *G*, which is moved by screw *H*. These designs are varied somewhat at times to suit the work. The tools shown have been in practical use several years and are doing good service to-day, as nothing has been found to satisfactorily take their place. W. S. MARQUIS.

Washington, D. C.

DIMENSIONING WORM AND WORM-WHEEL DRAWINGS.

Recently, while assisting in building a machine that had a worm drive I noticed that the center distance of worm and worm-wheel was given in decimals carried to three places. Now, why cannot the center distance be given in figures that agree with the graduations on a scale the machinist generally uses, namely, 16ths and 32ds, and the necessary decimal dimension which almost always enters into a worm and worm-wheel design be applied to the diameter of the worm where it can easily be measured by micrometers? For an example let us assume that we have a worm that is 2 inches outside diameter, driving a worm-wheel of 40 teeth, ¼ inch pitch, the pitch diameters being 1.8408 inch and 3.183 inches respectively. Now one-half the sum of the pitch diameters will be the center distance.

$$\frac{1.8408 + 3.183}{2} = 2.5119 = \text{center distance.}$$

Suppose we call the center distance 2.5. The difference will be 0.0119. Multiplying this difference by two and subtracting from the original pitch diameter of worm we have 1.817 for the new pitch diameter. This gives us a worm that is 1.9762 outside diameter, and we can easily caliper to these figures with the micrometer. Of course the angle of thread is slightly changed but so little that it can do no harm. If it would be impracticable to decrease the diameter of the worm owing to it having a large hole, then the diameter can be increased so that the center distance will be in 32ds. ALPHA.

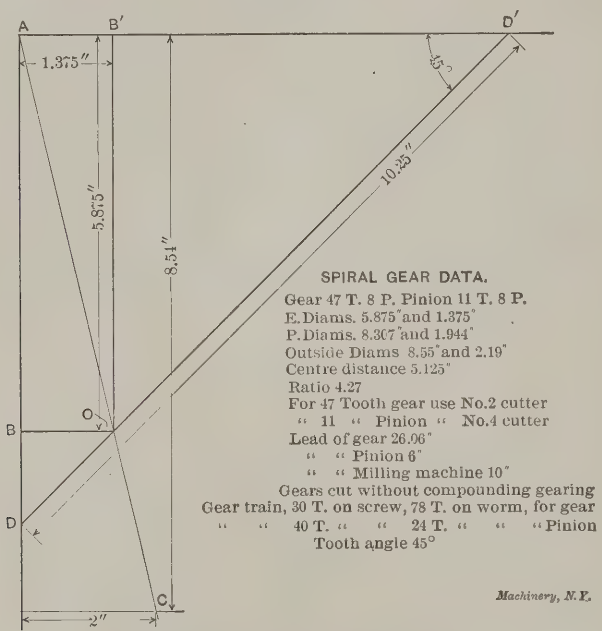
[One objection to the system of dimensioning proposed, and the one which has, perhaps, in many cases prevented the adoption of this way of dimensioning is that the hobs used for cutting the worm-wheels would all be of special diameters, and for each new design of worm and worm-wheel drive, not fully identical with one already made, there would have to be a new hob made. When the worm is made of a standard diameter, any firm having a large number of hobs on hand can often make the worm of such a size as to save the making of a new hob for every new design.—EDITOR.]

DESIGNING A PAIR OF SPIRAL GEARS.

A few days ago I had the task set me of redesigning a pair of spiral gears with which two previous draftsmen had had trouble. The gears made to the figures they had calculated had to be finished by the cut and try process. It was my first experience with spiral gears, so I approached the matter rather cautiously. I had kept in my file a copy of the May, 1906, issue of MACHINERY with the article on spiral gearing, and I used this for a start. When I finished the calculations the results were so far away from those obtained by the men who tried it before that I was almost afraid to use them, but I said nothing and sent them out into the shop. The foreman and milling machine man were a little bit skeptical, but everything worked all right, and the only change that was made in anything was the use of a No. 3 cutter where the

figures called for a No. 4. The following diagram and figures show how I obtained the results:

According to the directions given in the article referred to, I first drew lines $A D$ and $A D'$ at right angles to each other, and then drew the ratio line $A C$. Since I wanted 11 teeth in the pinion and 47 in the gear, my ratio was 47 divided by 11 equals 4.27. On my diagram I located C 2 inches from line $A D$ and 8.54 inches from line $A D'$, this being in the ratio of 1 to 4.27. I decided to have the gears with a tooth angle of 45 degrees. The center distance between the axis of the gear and pinion was supposed to be about 5 inches, and the diametral pitch of the tooth somewhere near 8. Holding my scale, then, at an angle of 45 degrees with lines $A D$ and $A D'$, I moved it vertically upward with the zero graduation on line $A D$, until I found such a position for it as that shown in the sketch, where point O, which marks the intersection of the rule with the ratio line, is 11/8 inch from line $A D$ and 47/8 inches from line $A D'$. 11/8 inch 1.375 inch would be the pitch diameter of an 8-pitch spur gear of 11 teeth, and similarly 47/8 or 5.875 inches would be the pitch diameter of a 47-tooth gear, 8 pitch. The distance $D D'$ measured on my rule about 10¼ inches; the diagram makes this twice the center distance, so the center distance would be 5⅛ inches—which was near enough to suit



The Solution of a Spiral Gear Problem.

me. $D O$ is the pitch diameter of the small gear, 1.944 inch, while $D' O$ is the pitch diameter of the large gear, 8.307 inches. The outside diameter of the two gears was found by adding 2/8 = ¼ inch to the pitch diameters of each gear, the same as in 8-pitch spur gears. Next I divided the number of teeth in the pinion by the cube of the cosine of the tooth angle, 45 degrees. This quantity was found in a table in the back of the Brown & Sharpe catalogue, but it may be found in almost any mechanical reference book in tables that are as easily read as a time table is. This division gave me 31 and a fraction. The table in the Brown & Sharpe catalogue stated that a No. 4 cutter should be used for cutting 31 teeth, so this was what the milling machine man was told should be used. Dividing the number of teeth in the gear by the same quantity gave me 123 teeth for this. The catalogue calls for a No. 2 cutter in this case. Following the instructions in the article referred to, the pitch diameter was multiplied by 3.14 and cot. 45 degrees. This gave me a lead of about 6 inches, to which to set the milling machine in cutting the pinion. Multiplying the pitch diameter of the gear by the same quantities gave me a length of about 26 inches to set the machine to in cutting the gear.

The only change that was made from these figures was, as stated before, the substitution of a No. 3 cutter for a No. 4 in cutting the pinion; otherwise the calculation worked out very nicely. CHARLES A. HEALD.

Nashua, N. H

WHERE QUICK JUDGMENT SAVED DOLLARS.

An instance recently occurred which showed how a foreman having that quality which enables him to quickly decide and act to the best advantage in cases of emergency is far more valuable to a firm than one who can only do things in the orthodox way. In a large machine shop, containing large boring mills up to 140 inches, lathes up to 120 inches, large planers, slotters, etc., there were two forty-ton electric cranes on the lower, and an eighty-ton electric crane with two travelers on the upper runway. Once the latter crane was near the end of the shop lifting a heavy job out of a lathe. Suddenly the controller to the hoist motor burned out, leaving the job just off the lathe and tieing up both of the smaller cranes which were in the short end of the shop. The only thing to do, in the opinion of the foreman, was to repair the controller, which was done in the course of three hours, and in the meantime many machines were waiting for crane service which they could not get on account of the two small cranes being held prisoners. The large crane could not bridge away, and the job hanging on the dead trolley was too high to unhook and too low to carry over the machines. The machines thus made idle were all highly rated, and with the machine hands they totaled up to a nice sum before they could resume operations.

A few weeks later a similar accident occurred to the same crane while the hook was too low to pass over the machines. The forty-ton cranes were one on each side of it. This time another foreman was in charge and instead of ordering it to be repaired in the usual way, he disconnected the four motor wires from the burned out controller and attached them to the hoist controller of the second trolley, thus allowing the crane to go about its business while the bad controller was being repaired. The delay was not more than ten minutes. Another similar accident occurred on a single trolley crane some time later when an important shipment was being made and time meant money; the controller of the hoist motor burned out with the job hanging on. In this case the bridge controller was substituted to make the lift, changed back to bridge over the car, then changed again to lower the job off, the total delay not being over fifteen minutes. The money saved in these two cases, by getting the cranes quickly in running order while the controller was being repaired, must have amounted to quite a considerable sum, yet these valuable qualities in a foreman seldom receive consideration.

Philadelphia. MASTER MECHANIC.

[The cases referred to above, in our opinion, are not so much examples of lack or possession of judgment, as of, on the one hand, ignorance and, on the other hand, knowledge of the principles of electrical apparatus. The occurrences, however, strongly accentuate the necessity of the men in charge of machine shop departments being to some extent familiar with the principles of action of all the machinery in their charge.—EDITOR.]

GRADUATING IN THE MILLING MACHINE AND THE SHAPER.

The average shop rarely boasts of a dividing machine or of any means of graduating other than that afforded by tools regularly engaged on general work. When such jobs have to be done they seldom admit of a special expenditure; this, coupled with the fact that clean-cut, evenly-spaced graduations have a "setting-off" effect analogous to that of neat lettering on a drawing, has caused the following suggestions to be proffered.

Much of the work ordinarily encountered is the making of scales. A good miller having feed screws supplied with dials reading to 0.001 inch is well adapted for such work. The divisions are cut with a perfectly sharp 60-degree double-angle cutter set to a depth usually not over 1-64th of an inch; for coarse graduation use a 90-degree cutter. The piece to be graduated is held in the machine just as for any other operation and must be brought in correct relation with the cutter for the first division line. When, by feeding with the table screw, the proper length of line is cut, set the stop, and run up to this each time. If the lines are not to be of a uniform length it is usual to mill the longer one first, going over the

scale again for the others; or if this is inconvenient, a spacing piece may be inserted in front of the stop each time a short line is cut. It is, of course, understood that, after the first line has been made, the dial on the cross feed is used for indexing.

Should the proper cutters not be at hand, the rolling or "squeezing" tool, Fig. 1, is easily made and is capable of long and excellent service. The body, made of steel, is bored to slip on the arbor and the sides of the hub faced true with the hole. The slot at the outer end is a snug working fit for a hardened and ground carbon steel roller. When using this tool the arbor must be secured from turning—otherwise, proceed as with the cutting method. Rolling produces finer finished work than milling, but, as shown exaggerated in Fig. 2,

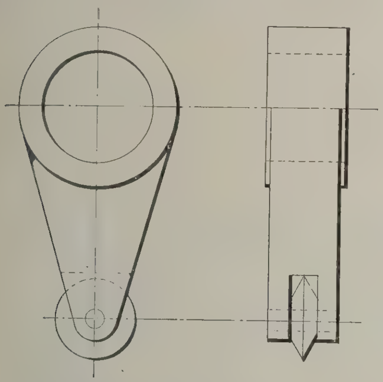


Fig. 1. "Squeezing" Tool for Graduating in the Milling Machine.

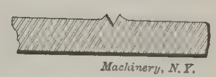


Fig. 2. Exaggerated Appearance of Impression Made by the Squeezing Tool.

always throws up a burr that has to be removed. This tool cannot be used to advantage on cast iron or for light accurate work. Another class of work frequently met with and best done on a milling machine calls for graduations on the outside surface of a cylindrical piece. Such pieces are put on centers and the dividing head used for indexing. A milling cutter or squeezing tool is used for obtaining the graduations the same as before.

For shaper work use a 60 to 90-degree V-point tool. To make smooth lines it is absolutely necessary to have a sharp tool; hence (if the graduations are not to extend clear across the work), to prevent constant dulling of the point, provide a slight groove at the end of the lines into which the tool may run. Rolling can be done in the shaper with a tool similar to the one described for the miller, except that the shank is made to fit the tool-post and the machine is run with the clapper blocked. Here, again, this method leaves the smoother finish and does away with the drag of the clapper and consequent grinding of the V tool necessary. The shaper not being

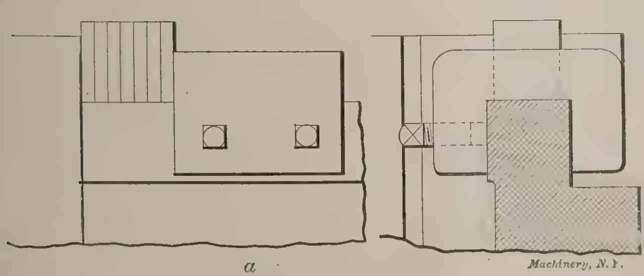


Fig. 3. Graduating in the Shaper.

supplied with a dial on the feed screw, some other way of indexing must be resorted to. One method is to make a clamp, Fig. 3, of cast iron or steel to slide on the top rib of the cross rail and secured by setscrews having brass plugs in front of their points. A number of spacing pieces, of a thickness equal to the "lead" of the scale to be cut, are provided. These are placed between the clamp and the saddle, as shown at *a*, Fig. 3. One spacing piece is removed for each line cut, and the saddle moved up against the remaining pieces. When all have been removed, the clamp is shifted and the operation repeated.

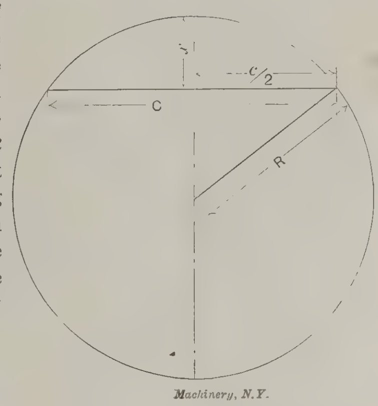
Less accurate graduations may sometimes be laid out with dividers or marked from existing surfaces. For such cases, the scale surface is coated with copper solution and the lines scratched on it, the work being then put in the shaper or miller and the divisions cut as nearly as possible to the scratched lines.

DONALD A. HAMPSON.

Middletown, N. Y.

R. S. SOLVES A PROBLEM.

The editor of MACHINERY has sent me a letter which he has received from one of his more or less valued correspondents. It is a pleasure to me to say that the correspondent in question is very anxious about my health and general welfare, all of which, of course, is very agreeable to me, and makes me realize that others have recognized what I have long known myself, namely, that I am a person of importance and of interest to the public at large. The correspondent in question, however, in all his kindness still seems to doubt my extraordinary mathematical ability, and after having said some things he ought not to have told about his former teachers and instructors, he submits to me the problem of finding the radius of a circle when the length of an arc and the corresponding chord are known. It almost hurts my feelings that he should even suspect my incapability of attacking so simple a thing as this. Now suppose that C is the length of the chord and l the length of the arc. Let R be the radius to be found. The height of the arc we will call x. We have now two unknown quantities, R and x. If we can get two equations containing these quantities we can eliminate the one in one equation, and thus solve our problem. It is easily seen that



R. S. Solves a Problem.

$$R^2 = \left(\frac{C}{2}\right)^2 + (R - x)^2 \qquad (1)$$

According to a geometrical proposition (Euclid, III., 35) the rectangle contained by the parts of each of two chords intersecting in a circle are equal. Thus,

$$(2\,R - x)\,x = \left(\frac{C}{2}\right)^2 \qquad (2)$$

If x is solved in equation (1) and its value inserted into equation (2), this latter reduces itself to an equation with one unknown R, which can then easily be determined. I am, however, too busy at the present time promoting a company to launch my perpetual motion scheme to be able to demonstrate in full how simple the problem is. Let me say in conclusion that it is gratifying to know that the world is growing wiser every day. This is conclusively proven by the fact that only a very few people have reflected upon spending their hard-earned cash in buying the sole right to my perpetual motion. Those who have done so, I thank for their kindness, and assure them of my profound sympathy.

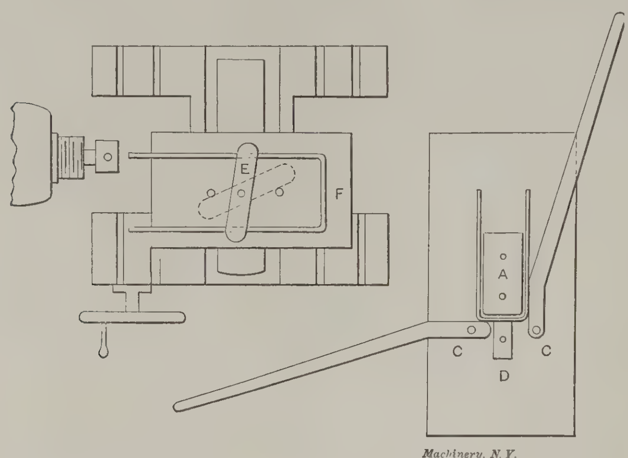
R. S.

TOOLS FOR BENDING AND THREADING IN A SMALL SHOP.

An order for five thousand 5/16-inch round pieces of wrought iron, bent to a "U" shape and threaded for standard nuts at the ends was received at a small shop, so small indeed that a working force of two men and three boys was considered ample for rush seasons. However, it was the only machine shop within twenty miles, and many and queer were the jobs which fell to its lot. A slab of cast iron 36 x 18 inches (the shops laying out plate) was set up in the middle of the floor, its upper surface being about the same height as a low table, a piece of boiler plate A was chopped out and ground to the inner shape of the sample piece. This was bolted to the center of the cast iron plate, and two levers were made and fulcrumed at pins C so that when a piece was placed in position and the levers forced around (boy power, the smaller the boy the longer the handle) the required shape was the result. D is a strap bolted behind A, which keeps the work up to its place. A stop was provided at one

side, so the boys would get the pieces central without loss of time.

Threading the ends was the next operation. The compound rest of *the* lathe was removed and in its place a large block of wood was bolted down, on the upper side of which a groove was hollowed out to the U-shape of the wire, and so that when a piece was laid in, it came flush with the surface and the two ends protruded over the forward end about 1½ inch and were level with the lathe center line. A swiveling

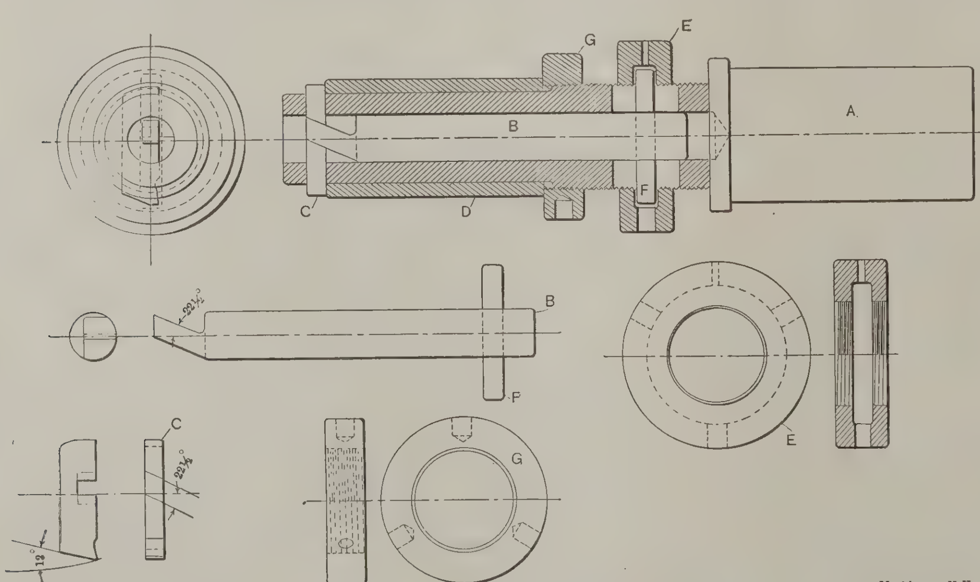


Simple Bending Rig and Arrangement for Threading.

iron clamp *E* served to hold the piece in place, and the thrust of starting the thread was borne by the wood at the end at *F*. The cross-feed screw was removed and the operator after threading one end pushed the whole thing over until the other end was in a position to enter the die and then gave it a start with the hand-wheel on the carriage. The lathe was never stopped except at the moment of reversal, and I dare say, as these moments were short enough to be unobserved by the average eye, many would-be philosophers argued that the lathe never stopped at all. W. L. McL.

SCREW MACHINE RECESSING TOOL.

The accompanying cut shows a screw machine tool for recessing castings which, beside being simple to operate, is an important factor in turning out work accurately and rapidly. In the cut, *A* represents the holder, one end of which fits the turret of the screw machine, while the other end is



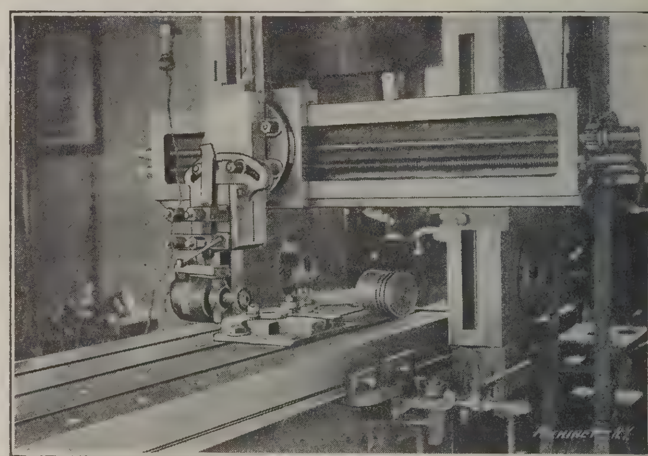
Screw Machine Recessing Tool.

bored to receive rod *B*. One end of this rod is milled to allow adjustment in both directions for the tool steel cutter *C*, which in turn is slotted to suit the angle on the end of the adjusting rod. Bushing *D* acts as a pilot, being turned to the bored diameter of the work. Adjusting nut *E* is screwed on the threaded portion of holder *A* and moves the pin *F* which is driven in the end of rod *B*, the travel being guided by the slot in *A*. Check nut *G* is used to regulate the depth of the cut and is operated on the same thread with *E*. Both nuts are of machinery steel, casehardened, knurled and provided with three holes permitting the use of a spanner wrench.

The operation of the tool is as follows: Adjusting nut *E* is screwed forward until the cutter is set to the depth of the cut desired. Check nut *G* is then set against adjusting nut *E*, which is screwed back until the cutting point is below pilot bushing *D*. The turret is then fed forward, bringing the tool into the work. Adjusting nut *E* is gradually brought up against check nut *G*, bringing the cutting point to its full depth. When this is done the automatic feed of the machine is thrown in and the tool performs its work. The only qualification necessary to make a tool of this kind universal for various sizes of work is to provide pilot bushings and tools to suit the required diameters. W. T. M.

GRINDING PISTON RINGS ON THE PLANER.

The use of a 24-inch x 6-foot planer for grinding 4-inch gas engine piston rings is, to say the least, hardly good practice, but in our case it seemed to be the most feasible way of ac-



Grinding Piston Rings on the Planer.

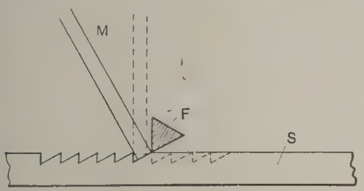
complishing our purpose, since there was no surface grinder available. The device was arranged as shown in the cut. A small electric grinder with ¼ x 3 inch emery wheel was fastened to the tool box of the planer, and a raising table, taken from the milling machine, was bolted to the platen. The rings were turned on one side in the lathe before being cut off. They were then fastened to the table by two bolts with washers. The ring was allowed to project slightly over the edge of the table so that it might be measured with micrometers. Having measured the tool used to groove the pistons, any desired fit could be obtained. Only one-third of the circumference could be ground at one time, necessitating three changes. The time consumed was seven minutes, but this could have been reduced by using a wider-faced wheel. The fit of the rings in the piston groove when thus ground was all that could be desired. C. F. MOORE.

Rochester, N. Y.

HOW TO MAKE A SAW.

The following is not intended to give you an idea of how to start in the saw-manufacturing business, nor does it mean that this is the only way of making saws. But it is intended to show that for some emergency purposes, ever occurring, you can without great efforts and skill make a good saw in a short time. In Fig. 1 are shown the triangular file *F*, the

"saw to be," *S*, of some spring tempered steel blade, and a piece of metal (or end of a file) *M*, this latter varying in thickness according to the size of tooth wanted. Now all you have to observe is to file the first tooth with a few strokes of the triangular file to the proper depth, to insert piece *M*, which serves as stop, and file the second tooth, and so on, always trying to get the teeth as uniform as possible. By changing the angle of *M*, the size of the teeth may be increased or decreased without going into trouble of searching for an exact piece to fit. Remember as well, that a saw with undercut teeth will saw iron and steel, while teeth cut down straight as shown in the illustration will be suitable to cut brass, bronze, etc. To avoid the cumbersome job of staggering the saw-teeth sideways, you may as well raise a burr at the point of same by a light hammering of the points with a small hammer and afterwards refinish them with the file, giving



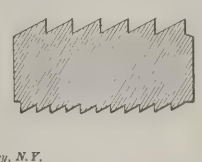


Fig. 1. Making a Saw with a three-cornered File.

Fig. 2. Section of Special "Saw-file."

a sharp cutting edge. The burr being left on will prevent wedging of the saw in cutting metals. This method of making a saw is rapid and saves you, in time, lots of annoyance, especially when cutting narrow slots, for which purpose generally no files can be had the moment they are wanted.

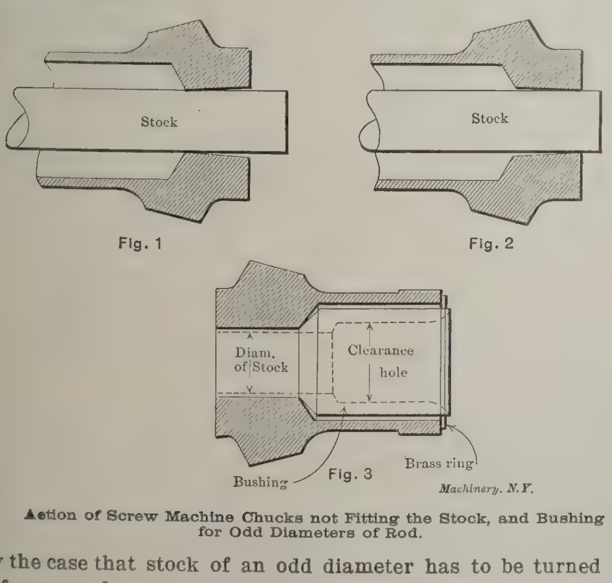
Fig. 2 shows a section of a "saw-file" which the author has seen used in a shop down south, turning out surgical instruments, and is a more fitting means of doing aforesaid trick with much greater accuracy and in still shorter time; it will prove indispensable to those who find it of value to make their own saws as it will cut from 5 to 20 teeth at a time—depending upon number of teeth to the inch and width of file. The use of this tool is self explanatory, the cost of manufacture is little, and if put into proper use will be a jewel in the tool box. MAX J. OCHES.

Cleveland, Ohio.

BUSHING FOR TURNING ODD DIAMETERS IN THE SCREW MACHINE.

Most screw machines are equipped with a series of spring collets or chucks for holding stock of different diameters. The sizes of these collets or chucks on the larger sizes of machines usually vary a sixteenth of an inch. It is frequently the case that stock of an odd diameter has to be turned up. Of course, for very small variations from standard sizes it is quite practicable to adjust the tightening clutch at the other end of the spindle. Let it be required, however, to hold stock that varies one thirty-second of an inch from the nearest size chuck, say for instance 19/32-inch stock; now, a 9/16 chuck is too small, and a 5/8 chuck too large for this diameter. To attempt to adjust either of these chucks to hold the stock, puts an undue strain upon them, and, in the writer's experience, has broken a number of chucks. Moreover, the stock rarely runs true, and is not held firmly as only the front or rear end of the chuck grasps the stock (Figs. 1 and 2). To overcome this, the writer has tried the following device which consists of a brass bushing as shown in Fig. 3. It is made about 1/16 inch longer than the chuck to which it is soldered by means of the brass ring shown in the figure. It has, of course, slots corresponding to the slots in the chuck to allow opening and closing of the chuck and bushing. These slots, however, do not extend the full length of the bushing, but just far enough to give a suitable amount of spring to it. This device has been found entirely satisfactory and is very inexpensive, and moreover, saves the risk of breaking the chuck. FREDERICK WALSLEBEN.

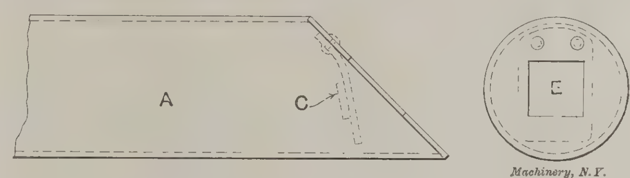
Brooklyn, N. Y.



Action of Screw Machine Chucks not Fitting the Stock, and Bushing for Odd Diameters of Rod.

SAFETY VALVE FOR BLAST PIPES IN BLACKSMITH SHOPS.

Reading in the February issue of MACHINERY an article by Albert P. Sharp on safety valves for blast pipes brings to my mind a case that occurred to me several years ago. Due to the accumulation of gas in a large blast pipe, an explosion resulted, wrecking the whole shop. Knowing that the same thing would occur again unless something was done to prevent it, the device shown in the accompanying cut was devised. This device answers, I think, fully as well as the method proposed by Mr. Sharp and will cost only a quarter or less of what his device would cost. Referring to the cut, *A* is the end of the blast pipe, which in most cases is 6 inches in diameter



Safety Valve for Blast Pipes in Blacksmith Shops.

or more. This end should be cut off at a slant of 45, 50, or 55 degrees. A piece of galvanized iron should be fitted to the end as a cover and then a square hole *E* cut in the cover. A piece of leather, for instance, the thickness of belting, cut large enough to cover the hole *E*, and long enough to allow for rivets at the top, and with a piece of lead *C* to act as a weight, is fastened to the galvanized iron cover, as shown, to complete the valve. When the pressure is on, the leather cover is forced over the opening *E* and closes it, but when the pressure is off the leather drops down by the action of the leaden weight and allows the passage of air and gases through the pipe. This idea, I think, is original, simple, cheap and absolutely safe. I have introduced it in several shops which I have equipped. GEORGE T. COLES.

Chicago, Ill.

I CAN'T DRAW, BUT I KIN WHITTLE.

Some years ago I was running a machine shop with foundry and pattern shop connected, manufacturing one or two specialties, which was hardly enough to keep the shop running to its fullest capacity. I did not like the idea of taking in hurry jobbing work, as that would interfere with our system of manufacturing, so I decided to advertise that we were prepared to build special or experimental machinery, and issued the following bulletin:

ATTENTION INVENTORS—A LONG-FELT WANT FILLED.

The undersigned now offers you the services of from ten to fifteen first-class mechanics, equipped with the latest improved machine tools suitable for building large or small machinery. All inventions kept strictly on the quiet, and warranted *not to leak.*

In less than one week I had to hire an additional typewriter, and it took all my time dictating answers to fellows who had an "idea" and wanted me to design the machine, all the way from a hog ringer to a valveless steam engine.

I had adopted Professor Sweet's idea of throwing the shop wide open to visitors, as a kind of advertising exhibition. These inventors swarmed into the shop, stood over the workmen, and asked them why they did the work in that way, or

why they did not do it in some other way, until my patience was exhausted. One morning I went into the pattern shop, and there was a tall, raw-boned Hoosier. He had on a big, rough straw hat, such as farmers use when plowing, and a long linen duster that reached down to his heels. He was standing at the back of the leading pattern-maker's bench, leaning half way over, and almost under the pattern-maker's nose held the index finger of his left hand in a horizontal position, using the finger and thumb of his right hand as a pair of calipers, and was calipering his index finger first at one end and then the other.

As I came up, the pattern-maker said to the stranger, "This is our superintendent, I did not get your name." The stranger turned to me and said, "My name is Wellwater, from Pike County, Missouri." Continuing, he said, "I was trying to explain to your man here what I wanted, but he don't seem to catch on."

"Have you a drawing of what you want made?" I asked.

"Drawing," said he, "I ain't got no drawing. I guess I can tell you better than with a drawing what I want. You see, I am getting up a corn-planter, I mean a corn-dropper, or that is, I want a valve made for a corn-dropper, one as will drop four grains in a hill, no more, no less, and not chop the corn into hominy, either."

"That is an excellent idea," I said, "but, as you cannot furnish a drawing we will have to charge you fifty cents an hour for talking."

His hands shot into his duster pockets, he leaned forward, stuck out his chin and looked me straight in the eye, and said, "Is that so?" Then he turned on his heel and left the shop. In half an hour or so he returned, tapped me on the shoulder, and said, "Say, can you make me a couple of pieces like that?" at the same time taking from his pocket a model of the valve which he had cut from a potato. When he previously left me he went up to the corner grocery and got a potato, sat down on the curb stone and whittled out a model, the exact size and form of the valve he wanted made. It was really an artistic piece of carving, the curves were smooth and graceful. It was hollowed out, leaving the walls and bottom about one-eighth of an inch thick, and the two side lugs, intended to receive the connecting pin, were reinforced with proportional bosses. I could not help admiring the rounded corners and graceful curves.

Holding up the potato model between his big, rough fingers, he said: "I can't draw, but I *kin* whittle." THOMAS HILL.

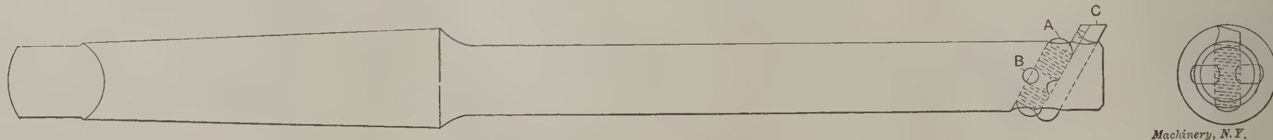
Quincy, Ill.

BORING TOOL FOR MILLING MACHINE.

The accompanying cut shows a boring tool which is very useful for boring holes in the milling machine. The object is to get a very fine adjustment, which is usually difficult on common boring tools. The adjustment is secured by turning the adjusting screw *A* which is prevented from longitudinal motion by a small pin *B*, engaging into a groove in the screw *A*. The cutter, of course, must be threaded on one side to engage with the screw. In making this tool I first drilled the hole for the cutter. After this, a pin was driven in the cutter hole and filed flush with the bar; then the hole for the adjusting screw was laid out and drilled. This hole is a plain hole, not tapped. Last of all, the pin hole *B* was drilled and the pin put in place after the adjusting screw had been inserted.

Hartford, Conn. R. P. JORGENSEN.

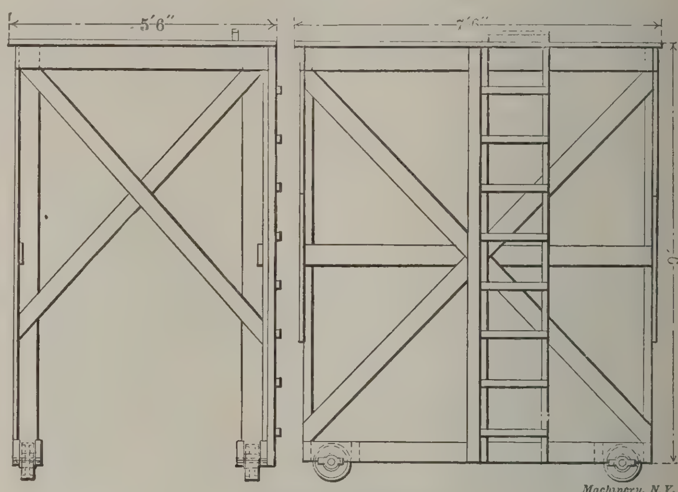
[Many of the readers of MACHINERY will probably recognize the construction of this boring tool as being the same as that of the Pratt & Whitney thread tool-holder, where use is made of an adjusting screw inserted in a similar way and engaging with a thread on the back of the single point cutter or chaser. However, the use of this construction in the present tool is novel and may prove advantageous in many cases.—EDITOR.]



Boring Tool for Use in Milling Machine

SCAFFOLD ON WHEELS.

A platform built on the manner shown in the cut is a great help in placing or repairing overhead pulleys and countershafts. For whitewashing and painting ceilings this scaffold is also very useful. The bracing is arranged so as to straddle the ordinary machine tool. A ladder is built on one side as shown. The wheels are of cast iron, 9 inches in diameter, 3 inches face. The axles, which run loose in cast iron boxes, are pressed into the wheels. A hand-hold on top of the platform, about 10 inches from the edge, facilitates in climbing up on the top. The platform is 7 feet 6 inches by 5 feet



Scaffold on Wheels.

6 inches and 9 feet from the floor; the height, of course, should be to conform with the height of the shafting.

To keep the shafting clean of oil and dust a pair of large "shears" of wood are used. A man standing on the floor holding the long ends, and having waste between the short ends, squeezes the shaft between the short ends, thereby polishing or cleaning the shaft. A. D. KNAUEL.

Moline, Ill.

THE FUNDAMENTAL PRINCIPLE OF PROPORTIONING MACHINE PARTS.

It frequently happens that it is desired to make some machine part of the same proportion as one already made, but having its weight, or strength, or some other property, either greater or less than that of the model, in a certain known ratio. A convenient way to obtain the new dimensions is to determine the algebraic power of the desired property, and to find the corresponding root of the known ratio. This may then be used as a factor with which to multiply the dimensions of the model to obtain the desired dimensions. Let it be desired, for instance, to find the dimensions of an anvil which shall have the same proportions but weigh three-fourths as much as one already designed. Since the weight is proportional to the volume, which has three dimensions, the multiplying factor would be $\sqrt[3]{3/4} = 0.9085$. If the desired weight is $1\frac{1}{2}$ that of the first anvil, the factor would be $\sqrt[3]{1.5} = 1.143$. Other instances where this method of multiplying factors would be useful are in determining dimensions of areas, where one, of course, makes use of the square root of the ratio; in determining size of shafting, working from a known condition, and section modulus of a beam, both of which cases require the third root of the known ratio; and the moments of inertia of sections, requiring the fourth root of the ratio. These are but a few of many applications that will readily suggest themselves. G. M. STROMBECK.

Urbana, Ill.

SHOP KINKS.

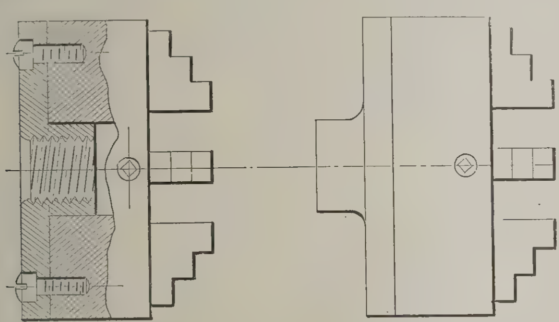
A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

In the description of the emery wheel dresser by Roy B. Demming which appeared in "Shop Kinks" February, 1907, it should have said that thin iron washers are used instead of tool steel, as there stated. These washers are made from sheet iron or Russian iron.

IMPROVED METHOD OF FASTENING THE LATHE CHUCK TO THE FACEPLATE.

To the left of the cut is shown an improved method of fastening a lathe chuck to the faceplate instead of fastening it as shown to the right of the cut, which is the usual way. Two important advantages are obtained by this change of method. The chuck will come nearer the bearing and a much

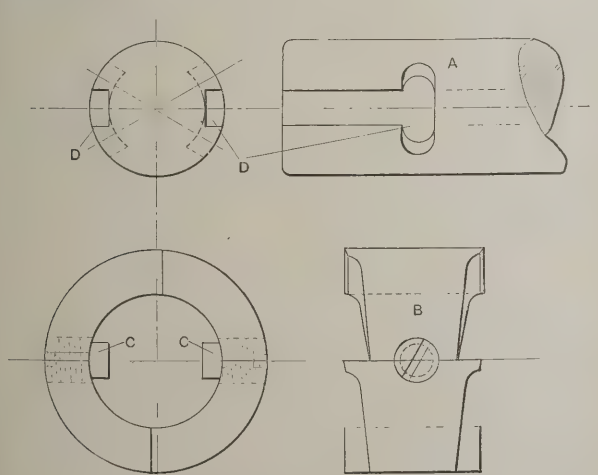


Machinery, N.Y.

stronger construction is possible. The method, as is plainly shown, consists of screwing the inside face of the faceplate to the chuck and allowing the hub to fit the inside of the chuck, the faceplate being finished all over and simply reversed from its usual position, which is to have the hub toward the lathe spindle and the face of the plate toward the chuck. WINAMAC.

FACING CUTTER.

A very useful and convenient form of cutter for facing around holes, either on top or bottom side of the work, is shown in the accompanying cut. *A* is the bar which may have straight or taper shank as required. *B* is the cutter which should be cut right and left hand as shown; it is held on the bar and driven by two screws *C C* which fit into slots *D D* of the bar. For facing around holes on the under side of

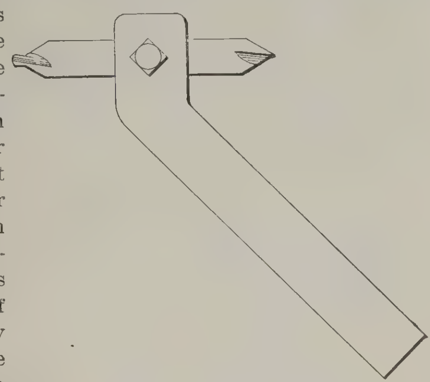


Machinery, N.Y.

flanges of large castings, where the end of the bar is first to be run through the hole and the cutter attached afterward, this cutter is easily put on or removed from the bar while it is running, thus saving much time otherwise lost by stopping. When desired, the keyways on each side of the bar may be cut their full length as indicated by the dotted lines; several sets of notches may then be cut to locate the cutter at different positions. M. S. W.

CENTER DRILL HOLDER.

The tool shown in the accompanying cut has proven itself a time-saver when centering work in the lathe, particularly shafting. The shank of the tool fits the tool-post and holds an ordinary center drill. One of the ends of the latter has the tit ground off and the lips are given sufficient clearance. When reversed in the holder this makes a most substantial tool for taking up centers. An examination of discarded center drills will show that few if any fail except by breaking off at the end where they join into the countersink.



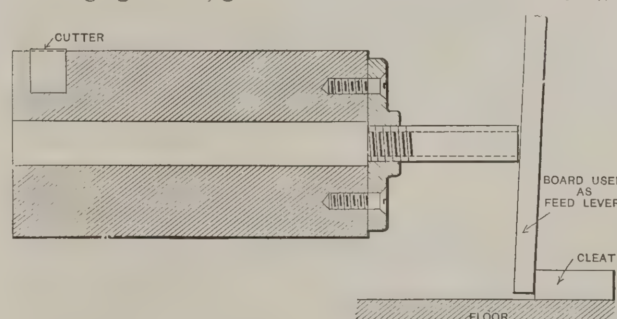
Machinery, N.Y.

To prevent this, grind off the drill part to less than half its original length, even shorter than shown in the cut, and the center drill can be depended upon not to break off, but to actually wear out. DONALD A. HAMPSON.

Middletown, N. Y.

A HOME-MADE BORING BAR.

We had occasion to send the water end of our boiler feed pump to the shop for boring and on getting it connected up ready for work again, we found it did not work as it should. It was packed with a special hydraulic packing, made to fit the cylinder; this would go tight into the outside ends, and after banging awhile, go to the other end with a rush. When



Machinery, N.Y.

calipering the cylinders, they were found to be smaller at the outside end, causing the packing to wedge in hard, while it was loose at the opposite end. Not wanting to again dismantle the pump we decided to rebore the cylinders, which were lined with bronze, in place. An oak block of the diameter of the cylinders was procured, and into one end of this was driven a file end, ground to the proper shape to form a cutter. On account of the location of the pump, the block could not be turned with a crank, so a floor flange was screwed to one end, and a piece of ¾-inch pipe of the required length screwed into the flange, the whole then being turned with a Stillson wrench. A hole was bored the full length of the block, so it was not necessary to remove the piston rods, but merely the plungers. A cleat nailed to the floor, with a piece of board for a lever furnished the feeding attachment. The cutter was set to the larger diameter of the cylinders, so nothing was cut out at the inside ends, and one setting answered for both sides. The pump ran as it should after this operation was performed. J. V. N. CHENEY.

South Portland, Me.

TO SHRINK HARD RUBBER.

Some time ago the cap of my fountain pen had worn so loose that it frequently dropped off. I held it a few minutes over a hot stove with the open end of the cap downward, and was pleased to find that the diameter of the opening decreased sufficiently to cause the cap to fit the pen holder just right. I have used the pen several months since the experiment, and the cap is still all right. This idea may be used in other cases in which hard rubber is employed.

Atlanta, Ga. W. S. LEONARD.

SHOP RECEIPTS AND FORMULAS.

A DEPARTMENT FOR USEFUL MIXTURES.

This page is intended to be used only for the publication of such shop receipts as the contributors know from experience to be practicable. Receipts are solicited on the condition that the contributors personally know that they are reliable. The fact that a receipt is old and supposedly well-known does not bar it provided it has not already appeared here.

324. SUBSTITUTE FOR RED LEAD APPLIED TO JOINTS.

As a substitute for, or in the absence of, red lead, use varnish on air or steam pipe joints. It will dry very hard and last for a long time. DONALD A. HAMPSON.

Middletown, N. Y.

325. CHEAP FLOWING SOLDER.

A cheap soft solder which is good for purposes where not much pressure is carried, is made by adding to each pound of lead, while melting, one teaspoonful of common salt.

Ashtabula, Ohio. C. L. SCOVILLE.

326. FILLING FOR CAST IRON.

One-quarter tumbler full of Japan dryer, 1½ ounce finely ground dry white lead. Mix and add 1 quart of finishing Japan. Stir in dry rotten stone until mixture is a thick paste. E. H. MCCLINTOCK.

West Somerville, Mass.

327. TO WELD SPRING STEEL.

An experienced blacksmith has used for years the following in welding steel springs. Just before the steel comes to a welding heat he placed a small piece of Russian sheet iron—such as stove bodies are made of—on the joint; this melts and runs into the joint so that the weld is perfect. X. Y. Z.

328. METAL POLISH.

A good metal polish for gold, silver, brass, nickel, etc., can be made by taking powdered crocus and mixing enough kerosene oil with it to make a paste. This paste must be rubbed very thoroughly over the article to be polished. Then take a flannel cloth and rub lightly and rapidly until a brilliant polish is obtained. HERBERT C. SNOW.

Cleveland, O.

329. CEMENT TO RESIST WHITE HEAT.

A cement that will resist white heat may be made of pulverized fire clay 4 parts; plumbago, 1 part; iron filings or borings free from oxide, 2 parts; peroxide of manganese, 1 part; borax, ½ part, and sea salt, ½ part. Mix these to a thick paste and use immediately. Heat up gradually when first using. W. R. BOWERS.

Birmingham, Eng.

330. BLACK OXIDE COAT FOR STEEL.

A fine black coat is produced on steel if treated in the following manner: An oxidized skin is first produced in some suitable manner on the surface of the steel; this is converted into black oxide by means of hot water and continued until the coat of oxide is thick enough. Then the articles are dipped in lukewarm water to remove any acid or salty particles, and then some olive oil is poured over the whole. D.

331. USE OF GLUE.

A mistake not uncommonly made by infrequent users of glue is to break up dry glue in hot water. This is bad practice as the adhesiveness is greatly impaired. Always soak dry glue in cold water and then cook, but do not cook too long as that is injurious also. Glue that has soured should not be used, and every precaution should be taken to keep it sweet if the best results would be obtained. M. E. CANEK.

332. UNCHANGING GLOSS ON CAST IRON.

The articles are well scrubbed with a diluted acid, dried and smoothed with a file, wire brush or the like. Then they are rubbed repeatedly with ordinary crude petroleum and let dry each time; finally they are well rubbed with a hair brush, which gives them a dark glossy appearance which will stand heat and serve as protection against rusting. Articles once treated in this manner need later on be only rubbed with petroleum and brushed up again. D.

333. BELT CEMENT.

Put 15 pounds of best glue in a kettle and pour over it 5 gallons of cold water. Let it stand a few hours or over night in a cold room, after which dissolve by gentle heat. Stir in one pint of Venice turpentine and add one gallon of Martin's belt cement. Cook for four or five hours by gentle heat, being careful not to boil the mixture. A water or steam jacketed kettle should be used to avoid burning. If too thick, mix with water. ALBERT F. BABBITT.

Attleboro, Mass.

334. MAKING WAX IMPRESSIONS.

It often happens that it is required in the manufacture of goods to make a wax impression of a sample or model. To do this successfully proceed as follows: Oil the surface of which the impression is to be made very slightly with a few drops of oil applied to a little waste. Then take common beeswax, melt it slowly, but do not boil it. Mix it with one or two tablespoonfuls of lamp black to half a tumbler of beeswax and stir the mixture. In order to make the wax impression show up clearly, take a fine hair brush and brush a little powdered graphite or rouge over the object on which the impression is to be made. C. W. SHELLY.

Wallingford, Conn.

335. TO FIREPROOF WOOD IN FORGE SHOPS.

To protect the woodwork around or near a forge apply three coats of 3 parts alum and 1 part copperas, dissolved in water. Apply hot, and only allow sufficient time between applications for the preparation to saturate the wood. Follow this with a fourth coat composed of solution of copperas made to the consistency of paint by mixing with fireclay. This treatment will not only render the wood fireproof but will preserve it for many times its ordinary life.

Another fireproofing mixture for the same purpose is composed of 3 parts ground wood ashes and 1 part boiled linseed oil. This is applied with a brush.

Still another fireproofing treatment consists of three applications of a hot solution of phosphate of ammonia. The last two treatments require renewing at least once a year.

E. W. NORTON.

336. DISINFECTANT.

It is frequently necessary to disinfect our offices or shops; a very effective and inexpensive means is as follows: To 6½ ounces of crystals of potassium permanganate, add one pint of formaldehyde (40 per cent) for every 1,000 cubic feet of room space. The disinfectant should be mixed in a metal receptacle having at least ten times the volume of the ingredients used. This is required to prevent the mixture from boiling over. The receptacle holding the crystals should be placed near the center of the room which is to be disinfected, after ascertaining that all doors, windows, etc., are securely calked to prevent the gas from escaping. The formaldehyde solution should be ready to be poured upon the crystals, which must be done quickly. The room must then be left closed for at least thirty-six hours to obtain the best results.

Denver, Colo. E. W. BOWEN.

337. HARDENING COMPOUND.

In hardening small tools, some of the more delicate and essential parts of the tool to be tempered are very apt to be overheated and burned unless extraordinary care is exercised. The following is descriptive of a compound that can be used to prevent over-heating of such small delicate instruments during the process of tempering. Dissolve 2 ounces of pure Castile soap in enough warm water to make a thin paste, and add to it the contents of a five cent package of lamp black, mixing it well into a stiff paste. This must be kept securely sealed in a can. To use the compound, slightly warm the small tool or object that is to be hardened, and smear the paste all over it. When dry, heat and quench in the usual way. As the paste is removed by the bath, the work will be clean enough to observe the color in tempering. T. E. O'DONNELL.

Urbana, Ill.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

Toolmaker.—Can you give me any information in regard to the Jarno taper? Are there any tables available anywhere for this taper, the same as for the Morse and the Brown & Sharpe standard tapers? What is the Jarno taper used for?

A.—The Jarno taper was proposed several years ago by Mr. Oscar J. Beale of the Brown & Sharpe Co. The taper per foot of all the Jarno taper sizes is 0.600 inch on the diameter. The Jarno taper has the advantage over the other two standard tapers mentioned in the above question in that there is an exact relationship between the diameter of the large end, the diameter of the small end and the length between the places where these diameters are measured, and this relationship can be expressed by simple formulas. The sizes of the Jarno tapers are known by numbers from 2 and upwards, and by simply designating the number of the taper, all other necessary dimensions can be determined by means of the formulas.

Let N = the number of Jarno taper,
D = the diameter of the large end,
d = the diameter of the small end, and
L = the length of the taper.

Then, $D=\dfrac{N}{8}$, $d=\dfrac{N}{10}$, $L=\dfrac{N}{2}$

If, for instance, we want to determine the size of a No. 7 Jarno taper, we find from our formulas that the diameter of the large end is ⅞, the diameter of the small end 0.700 and the length 3½ inches. If we figure the taper, we will find it to be 0.600 inch per foot, as stated before. As far as we know, there are no tables available outside of the manufacturing establishments where this taper is used, but on account of the simplicity of figuring the dimensions for the taper, no tables are actually required. This taper, although it has some very decided merits on account of being, one might well say, the only system of standard tapers founded on a scientific method, has not been used to any great extent. The Pratt & Whitney Co. has commenced to use it of late for several of their new designs of machines, particularly profiling machines, but it is safe to say that the old standard tapers, the Morse and the Brown & Sharpe do still hold their own in almost all ordinary machine shop practice.

C. K.—Kindly work out the spiral gearing problems indicated in Fig. 1; for each of the two cases the ratio is 1 : 1. The shafts are at right angles and the gears are to run at about 500 revolutions per minute. Also, will you please look over the following dimensions given for a pair of spiral

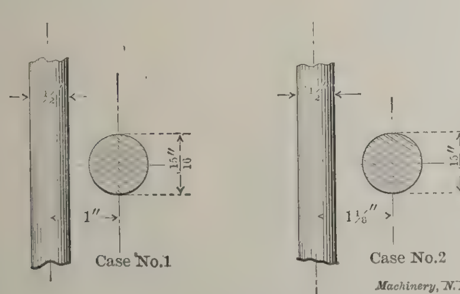


Fig. 1.

gears of equal dimensions: Twelve teeth each, 14 diametral pitch cutter, shaft angle 90 degrees, gear ratio 1 : 1, and tooth 45 degrees with axis. I make it the pitch diameter of these gears should be 1.212 inch, that the outside diameter should be 1.355 inch, and that the lead should be 3.808 inch.

The answers given below were obtained by the process described in the article on the subject of spiral gears, published in the May, 1906, issue of MACHINERY; reference should be made to this. The conditions shown in our correspondent's sketch in Fig. 1 hold us within very close limits as to diameters for these gears. We will take it for granted that the gears are to be made integral with the shafts on which they are mounted, otherwise they would merely be thin shells of no strength whatever. It is our object, then, to give them such pitch diameters that they will accurately fill the center distance given, and will be enough larger than the shafts of which they are a part to make it unnecessary to cut into these shafts when milling the teeth. The diagram for case No. 1, Fig. 2, shows these conditions fulfilled. This method of preliminary graphical solution requires that the ratio line for this case should be drawn at an angle of 45 degrees with the axis lines. The following dimensions have been worked out to fit the diagram, in accordance with the rules or formulas given in the article previously referred to:

	Gear on Large Shaft.	Gear on Small Shaft.
Number of teeth	12	12
Diametral pitch	18	18
Tooth angle	56° 10′	33° 50′
Pitch diameter	1.197 inch	0.803 inch
Outside diameter	1.308 inch	0.914 inch
No. of cutter used	No. 2	No. 5
Lead of spiral	2.521 inch	3.764 inch
Thickness of tooth	0.0873 inch	
Addendum	0.0555 inch	
Whole depth of tooth	0.120 inch	

The second case, of which a diagram is also shown in Fig. 2, may be given the same number of teeth and the same tooth

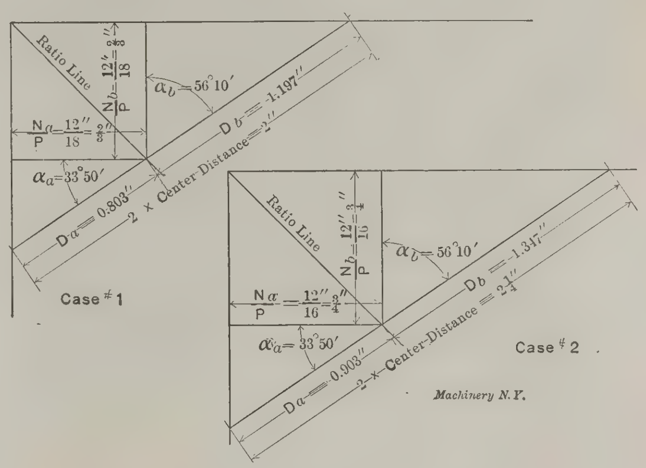


Fig. 2.

angles. This pair will in fact be merely that of case 1 on a slightly larger scale. The complete dimensions will be as follows:

	Gear on Large Shaft.	Gear on Smal Shaft.
Number of teeth	12	12
Diametral pitch	16	16
Tooth angle	56° 10′	33° 50′
Pitch diameters	1.347 inch	0.903 inch
Outside diameter	1.472 inch	1.028 inch
No. of cutter used	No. 2	No. 5
Lead of spiral	2.836 inch	4.232 inch
Thickness of tooth		0.0982 inch
Addendum		0.0625 inch
Whole depth of tooth		0.135 inch

It is conceivable that you might have good reason for wanting the pitch in these teeth different or for wanting their diameters changed slightly, in which case it would be possible to get new solutions to accommodate the conditions desired.

The dimensions you have given for the 45-degree angle gears are correct.

* * *

A combination wood and steel railway tie has been invented by Mr. Thomas A. Galt, Sterling, Ill., which is claimed to have a number of superior advantages. The steel portion consists of two parallel channels, lying on edge, with the flanged sides in and separated by a distance of about 8 inches. Firmly clamped between the channels by four through bolts are two sections of ordinary wood tie, each about 2 feet long, 8 inches wide and 6 inches deep. The combination affords the same simple spiking condition as the ordinary wood tie and the same elasticity. Samples of these ties have been placed in the main line of the Chicago & Northwestern R. R., in Sterling, Ill. It is asserted that the facilities for tamping the ties with the open channel bar construction are superior to the ordinary wooden tie.

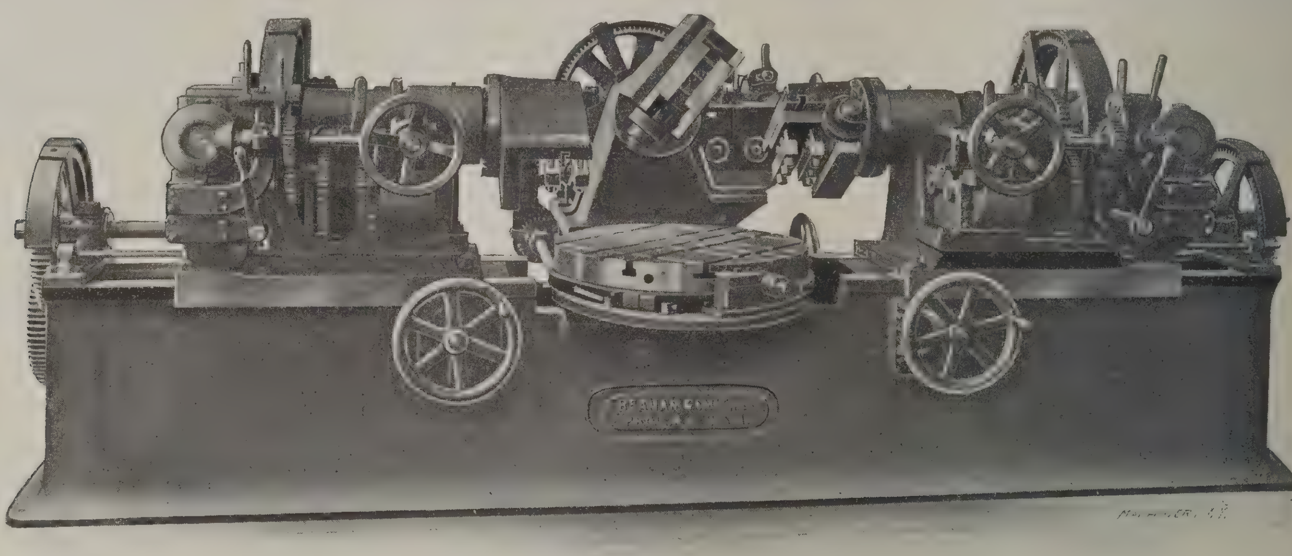
MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

BEAMAN & SMITH THREE-WAY FACING MACHINE.

The Beaman & Smith Co., of Providence, R. I., makes the machine shown in the accompanying halftone. It is used for facing one to three surfaces simultaneously on such work as valve bodies, cylinder castings, etc. It consists essentially of a circular work table which can be rotated to any angle, mounted on a bed carrying two oppositely disposing facing spindles, with a supplementary bed for a third facing head at right angles to the other two. All of the heads are driven by a single four-step cone and 4-inch belt through gearing which provides, in all, eight changes of speed of from 8½ to 40 revolutions per minute.

The circular work table, adjustable to any angular position, is graduated in degrees and has eight holes for stop pins.



Machine for Facing Three Surfaces Simultaneously.

Three surfaces may thus be operated upon simultaneously, and others may be faced at any angle in the same plane, means being provided to securely fasten the table in any position.

The in or out feed of the facing tools on the radial ways of the heads is effected by a feed screw, driven by a shaft passing through the center of the spindle, the arrangement being the same for each of the heads. By a patented construction the tool block may be adjusted by the operator by means of a hand wheel, this being possible whether the spindle is in motion or stationary. The feeds are 4, 8, 16, and 32 revolutions of the spindle to 1 inch travel, the ratio and direction being changed by means of levers conveniently located.

The machine will face to 28 inches in diameter. The least distance between the facers is 10 inches, and the greatest is 40 inches. From the center of the spindles to the top of the table is 15 inches. The weight of the machine is approximately 18,600 pounds.

FAY & SCOTT EXTENSION GAP LATHE WITH MOTOR DRIVE.

Fay & Scott of Dexter, Maine, have recently built a 24—46-inch extension gap lathe with motor drive, to meet government specifications. It is driven by a 5-horsepower Crocker-Wheeler motor with a 2 to 1 variation, through a silent chain drive to a sprocket on the spindle. The lathe is double back geared and is provided with a faceplate drive as well.

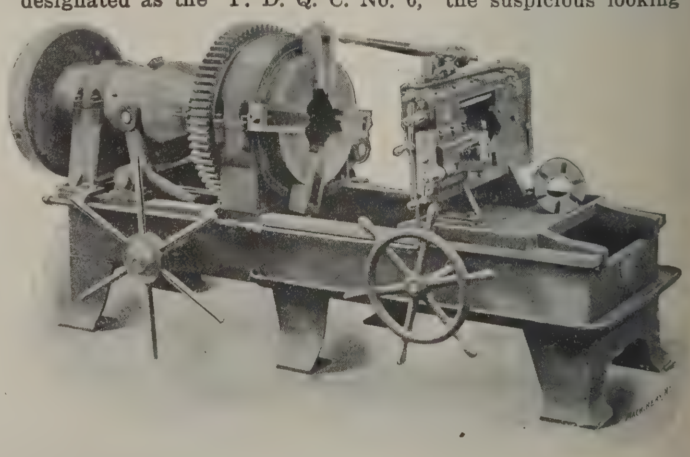
The general features of the builders' extension gap lathe are well known. A supplementary bed is adjustable longitudinally on the main bed. This may be moved up close to the headstock, when the tool is to all intents and purposes a 24-inch lathe. When it is desired to swing larger work up to 46 inches in diameter, the upper bed is moved backward until a gap of sufficient width is left to clear the work. The large faceplate may then be used with its direct drive for slower speeds. For large diameter work the extended cross slide is supported by a brace bearing on a finished way at the bottom of the bed. The fact that the width of the gap is adjustable, presents advantages obvious to any one who has use for a gap lathe.

A NEW DESIGN OF THE CINCINNATI LATHE AND TOOL COMPANY'S LATHE.

The 16-inch engine lathe made by the Cincinnati Lathe & Tool Co., Cincinnati, Ohio, may now be obtained in the double back geared style, with a three-step cone. This design is intended to meet the heavy duty required of modern machine tools. The lathe is provided with the W. T. Emmes' patent quick-change gear device, which gives forty positive-geared changes without alteration of the gearing. The back gears are of 3 1-3 to 1 and 9½ to 1 ratio, respectively.

BIGNALL & KEELER PIPE MACHINE.

The Bignall & Keeler Mfg. Co., of Edwardsville, Ill., has placed on the market a new pipe machine of a style and size designated as the "P. D. Q. C. No. 6," the suspicious looking



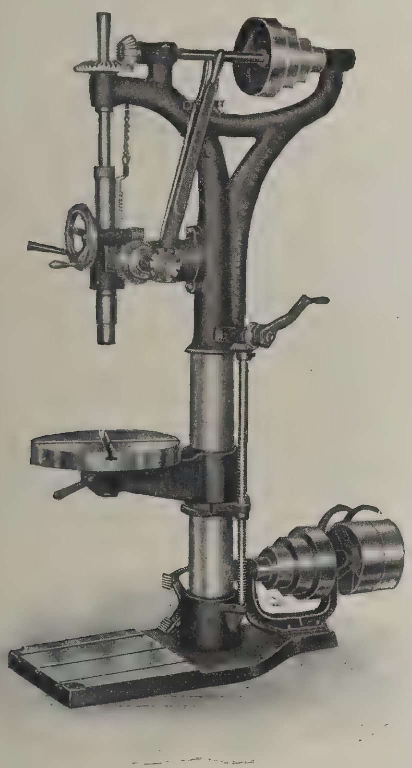
New Member of the Bignall & Keeler Line of Pipe Machines.

combination of letters used meaning nothing more serious than 'Peerless die—quick chuck." The chuck is operated by means of the pilot wheel shown in the cut at the head

end of the bed. The shaft on which this wheel is mounted carries a pinion meshing with teeth cut in the sector arm of the chuck lever, which operates the sliding cone encircling the spindle. As the cone is moved forward, the chuck arms, which are provided with rollers, run up on its large diameter, thereby tightening the jaws of the pipe. When the cone is moved back, springs draw the jaws away from the pipe. The jaws in the chuck are graduated and when once set for a given size no further adjustment is necessary for working with that size. A chuck is provided for the rear end of the spindle. This chuck has three independent jaws and is also provided with bushings for centering the work without gripping it. A four-step cone pulley and single back gearing gives eight changes of speed. The makers' well-known Peerless die head is used. This machine has a range of ten sizes of pipe, from 1¼ inch to 6 inches, inclusive.

THE SUPERIOR MACHINE TOOL CO.'S 21-INCH DRILL.

A new firm, the Superior Machine Tool Co. of Kokomo, Ind., is placing on the market the 21-inch upright drill shown in the accompanying halftone. It was designed by Mr. Albert E. Weigel, formerly superintendent of the Aurora Tool Works. It drills to the center of a 21-inch circle and will take 38 inches vertically between the base and the spindle, or 20 inches between the table and the spindle. The spindle has a feed of 8 inches, while the table is provided with a 16-inch vertical adjustment. A No. 3 Morse taper hole is used. The cone provides four changes of speed; the driving pulley should run at about 300 revolutions per minute. The net weight of the machine, which stands 6 feet high, is about 770 pounds.



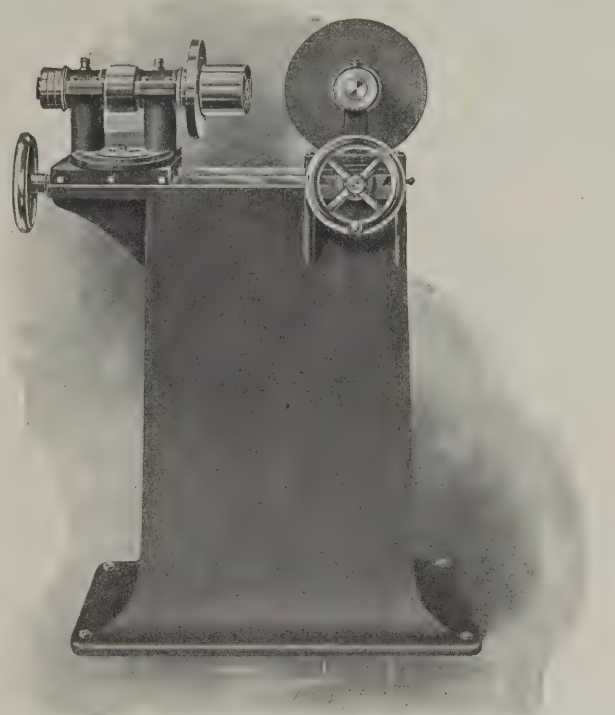
Superior Machine Tool Co.'s New Drill Press.

TWELVE AND TWENTY-FOUR-INCH ROCKFORD SHAPERS.

We have illustrated and described two sizes of the line of shapers built by the Rockford Machine Tool Co. of Rockford, Ill. These were the 20-inch, shown in the October, 1906, issue, and the 16-inch, shown in the November, 1905, issue. To this the concern has now added a 12-inch and a 24-inch size of the same general design. Among the strong points possessed by these tools might be mentioned the rigidly designed columns, high back-gear ratio, and carefully arranged system of control which places all handles and levers within reach of the workman on the operating side. The vise has an improved screw arrangement, such that the jaws are drawn and not pushed together, thus relieving the frame of strains which tend to spring it and impair its accuracy. Both the vertical and the cross feeds of the table are automatic and are driven by the same device.

A GRINDER FOR DISKS, PAPER SLITTERS, ETC.

This machine is built by the Bridgeport Safety Emery Wheel Co., Inc., of Bridgeport, Conn. It is designed for rotary face grinding of such parts as circular slitting cutters, saws, dies, punches, etc. The work may be held in a great variety of ways; a universal chuck is provided, but a Walker magnetic chuck may be used, or one of the plain 3- or 4-jawed type. The work may also be held on the revolving faceplate by means of an expanding arbor of the type shown, opened and closed by means of a screw. The work-carrying head swivels to any angle desired, thus enabling convex, concave or flat faces to be ground at either end of the spindle. The



Machine for Grinding Disks, Cutters, Etc.

head is mounted on dove-tailed ways gibbed to take up wear, and is fed in and out by handwheel and screw. Ring check nuts on the spindles take up all end play.

The machine is designed to be used either wet or dry. In the former case the wheel is enclosed with a hood, and pans are arranged to catch the water, which is returned to the large tank in the base where the dirt and sediment settles to the bottom, while the clear water is drawn from above by a centrifugal pump and forced back to the emery wheel and to the work being ground. The machine weighs about 500 pounds, has a faceplate 7 inches in diameter, and when the wheel is new, permits a distance of 6 inches between the platen and the wheel.

TWO NEW ARMSTRONG TOOL HOLDERS.

In Fig. 2 is shown a "3-bar boring tool" recently devised and placed on the market by Armstrong Bros. Tool Co., 113

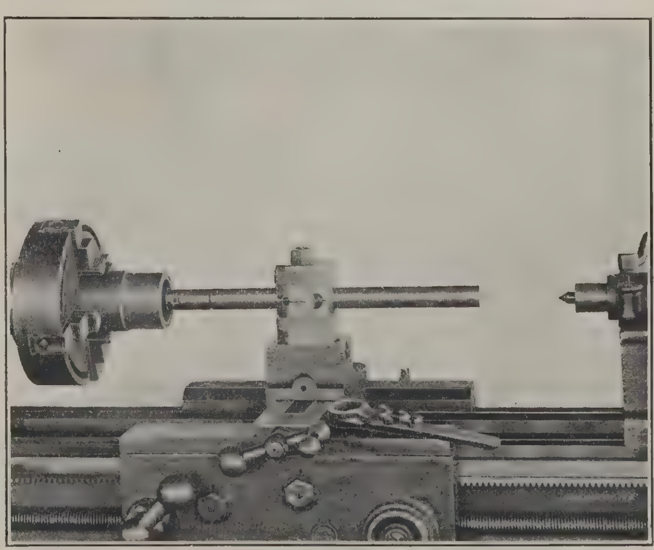


Fig. 1. Armstrong Boring Tool Holder in Use.

North Francisco Ave., Chicago, Ill. This combination of post and holder is made of bar steel throughout. The holder has a T-head fitting in the tool-post slot, to which it is clamped

by the nut at the top, which also serves to clamp the bars in place. Of these latter, as indicated by the name, there are three of different diameters. The fact that but a single turn of the wrench is necessary to release both the bar and holder, makes the change from one size to another a matter of seconds only, thus allowing the operator to use the stiffest bar possible for each job or each cut on the same job, with

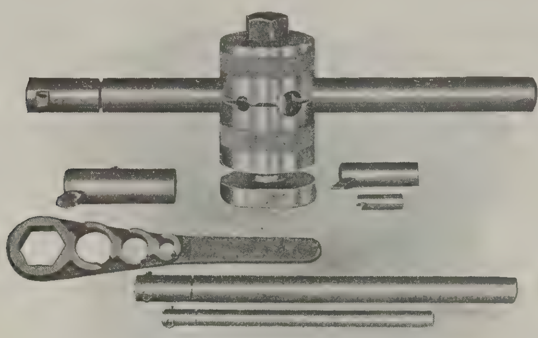


Fig. 2. Armstrong Three-bar Tool Holder.

the result that speeds and feeds can be increased and time saved. The wrench shown has one opening for the nut, and one each for tightening the cutters in the three sizes of bars furnished with the tool. The tightening of these cutters is effected in such a way that the pressure of the cut tends to hold them more firmly in position.

Fig. 3 illustrates an improved tool-post which combines in itself the strength and holding power of the strap and stud tool clamp, with the convenience of the open side and ordinary setscrew tool-posts. The construction will be apparent from the cut. It is made of drop forged steel throughout and consists essentially of a pair of jaws carrying tilting clamp-

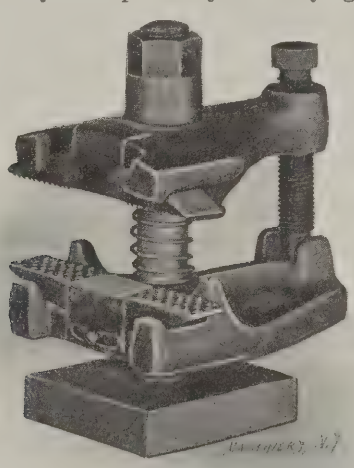


Fig. 3. Improved Tool Post.

ing faces; these jaws are pressed apart by a spring, and may be clamped together by the T-head bolt which passes through them and into the slot of the tool-block. A knurled head adjustable screw furnishes the rearward support for the clamping action.

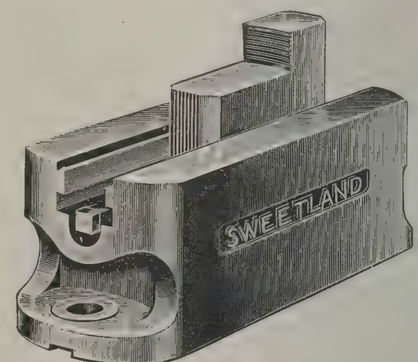
This tool-post is claimed to be stronger and stiffer than the ordinary type, will not slip or allow the tool to chatter and will consequently do more work. It will work up close to the chuck and has a great range of adjustment without loss of holding power, the jaws adjusting themselves on parallel lines; the open side permits rapid change and adjustment for tools; it will not cut or tear the tool shank and thus is particularly adapted to use with tool holders, and no trouble is possible from stripped or upset screws. By using V-blocks fitted to this tool-post, boring bars and similar tools of various diameters can be conveniently held.

IMPROVEMENTS IN THE DELPHOS OIL PUMP AND TANK.

In the February, 1906, issue of MACHINERY, we illustrated and described a non-overflowing pump and tank made by the Delphos Mfg. Co., Delphos, Ohio. This tank is arranged to fill with oil any sized receptacle brought to it, and return the excess to the reservoir in the base without allowing it to overflow. A double spout is used, one branch supplying the oil and the other returning the excess. As originally arranged, the device was used for handling the lighter grades of oil. Recent improvements, however, have made it possible to use the non-overflowing arrangement with the very heaviest liquids the tank will be called upon to carry. The 10-gallon size is a very popular one for factory use. Its portability is especially convenient where the keeping of lubricating oils in the factory increases the risk in the eyes of the insurance inspectors. The sales of this device have greatly increased during the past year and numerous re-orders have been received.

IMPROVED SWEETLAND FACE-PLATE AND JAW.

The accompanying cut shows a chuck jaw of the individual type, designed to be fastened in position on the face-plate of a lathe, boring mill or other machine of a similar nature. It



The Sweetland Face-plate Chuck Jaw.

is composed, as may be seen, of a rugged base casting, a hardened jaw, and an adjusting screw. The device may be used either way about, for holding work by the outside or by the bore. This device is manufactured in three sizes by the Hoggson & Pettis Mfg. Co., New Haven, Conn.

THE IMPERIAL AIR MOTOR HOIST.

The objectionable, and often prohibitory, features of the direct-acting air hoist are sufficiently familiar, and these are all conspicuous by their absence in the Imperial air motor hoist here shown. It does not require a great height above

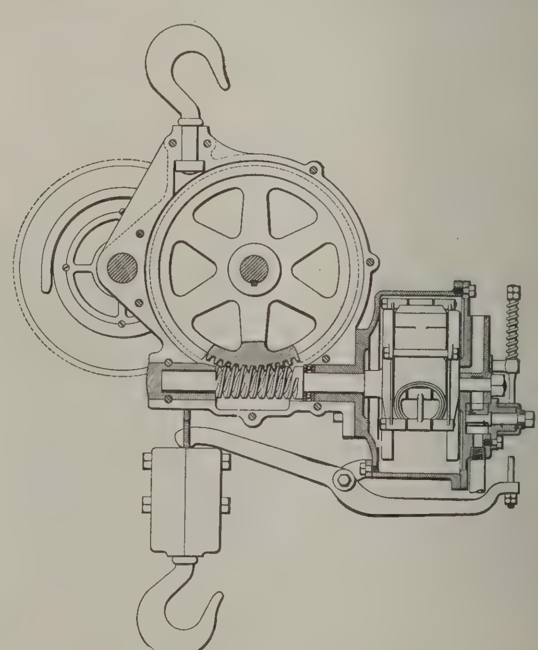


Fig. 1. Section of Imperial Air Motor Hoist.

the lift, and no more height for a high lift than for one not so high. The movement is perfectly controlled both for hoisting and lowering and the load is absolutely held at any point desired. There is no waste of air in filling long cylinders,

the amount used at any time being only that required for the actual work.

The motor is a positive-action reversible air engine, with no dead centers and a practically uniform torque. It has no delicate valve mechanism requiring adjustment or liable to get out of order. It is wholly enclosed, dust-proof, splash oiling, with every bearing bushed, and bathed in oil. The steel worm on the motor shaft runs in an oil pocket; its thrust is taken by a roller bearing; it meshes into a worm-wheel of bronze, a pinion on the worm-wheel shaft engaging the drum shaft gear. On the larger sizes of hoist there is an additional speed reduction; on all sizes the friction is the least possible, being minimized by the juxtaposition of suitable materials and by careful workmanship. The hoisting rope under-runs a sheave, which always permits an exact equalization of the two sides on the drum. The hook turns on ball bearings, so the load may be turned in any direction without twisting the ropes and without its turning back. The action is steady and smooth, twelve of the hoists being used for the delicate work of hoisting flasks in one foundry alone. The hoist is made in five sizes with capacities ranging from 1,000 to 10,000 pounds, using the ordinary air pressures. It is built by the Ingersoll-Rand Co., 11 Broadway, New York City.

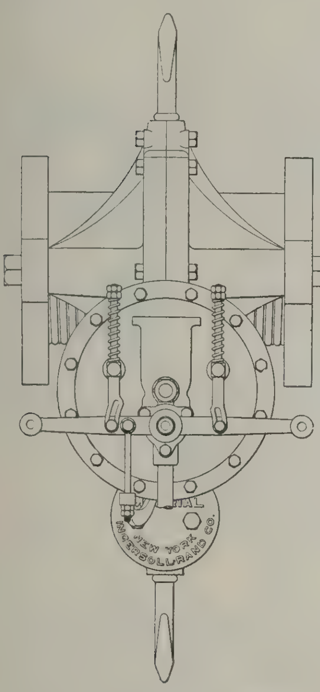


Fig. 2. End View of Imperial Motor Hoist.

THE THOR PNEUMATIC DRILLS.

In Figs. 1 and 2 are illustrated two of the "Thor" pneumatic drills made by the Independent Pneumatic Tool Co. of Chicago and New York. That shown in Fig. 1 is non-reversible.

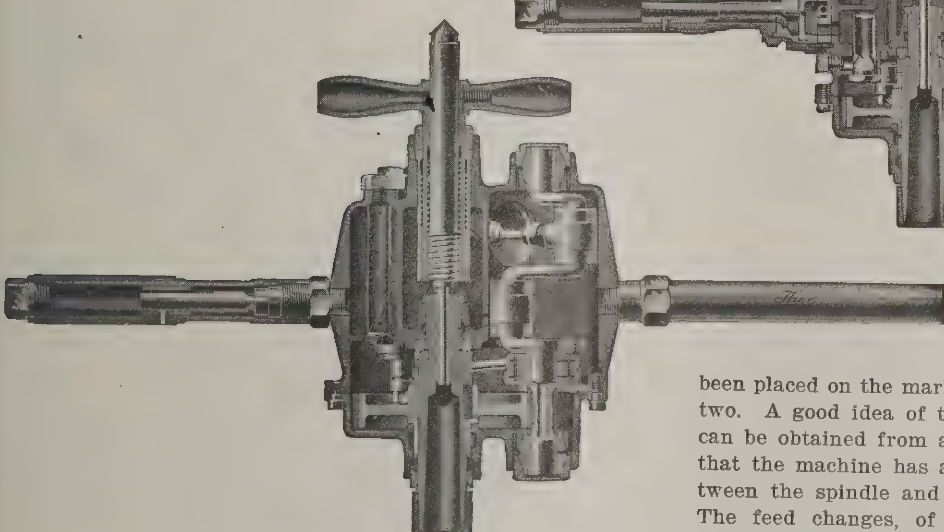


Fig. 1. The Thor Non-reversing Pneumatic Drill.

There are four single-acting cylinders in the body of the drill. The admission of air to these cylinders is controlled by Corliss valves immediately adjacent to the cylinders. These valves are operated from one double eccentric, which is provided with individual bearings independent of the crankshaft or of any other working part of the motor. This eccentric is driven by spur gearing. The crankshaft bearings are placed close to the crank, giving a saving in total length of the motor equal to the length of the eccentric. The feed is telescopic. An externally threaded stud works through an internally threaded sleeve to the extreme limit of its travel, and then the sleeve in turn screws out of the holder an equal distance, giving an unusual length of feed in an unusually short over-all height.

The motor is very accessible. By removing the exhaust caps, either valve may be removed without disturbing any part of the motor. The pistons may be removed by unscrewing the cylinder head, while the connecting rods may be taken out through the cylinder bore. The case of the motor is made with but one joint. The cylinder and gear case are steel castings, while all the other wearing parts are either steel forgings or are cut from solid steel stock.

The reversible drill shown in Fig. 2 is of the same general design as the non-reversible, except that the device for admitting air to the cylinders is arranged to cause the drill to rotate in the opposite direction when desired. This is done by a simple two-way valve placed in the admission chamber at the inner edge of the inlet pipe at the left of the illustration. This valve, when desired, sends the air through the exhaust port into the valve chamber and thus into the cylinders, instead of by the usual route. In both machines the controlling valve is placed close to the cylinders, so that the machine responds instantaneously to the movement of the valve.

These machines are made in fifteen sizes and are adapted to all classes of drilling, reaming, tapping, flue rolling, wood boring, etc. The manufacturers will send a machine on approval to any responsible person or firm desiring to try one.

OWEN PLAIN MILLING MACHINE IMPROVEMENTS.

The line of plain millers built by the Owen Machine Tool Co. of Springfield, Ohio, has recently been remodeled. Two sizes of this new line, known as the No. 2-B and No. 3-B, have

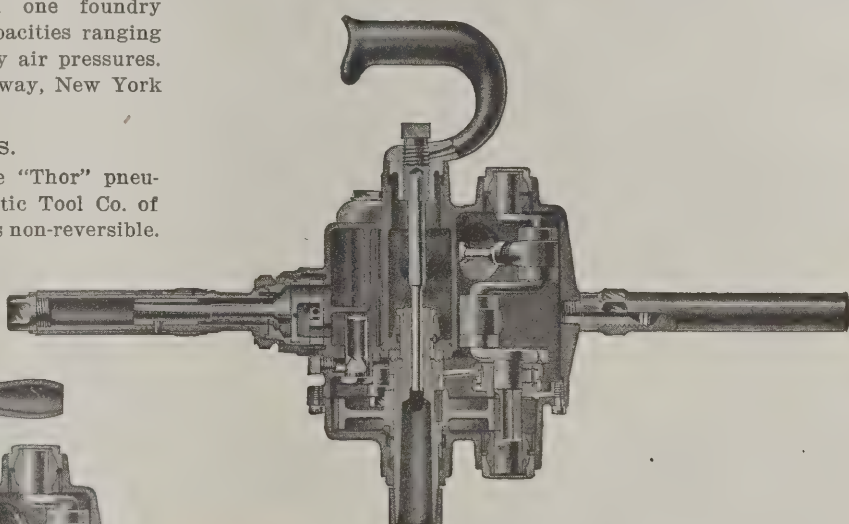


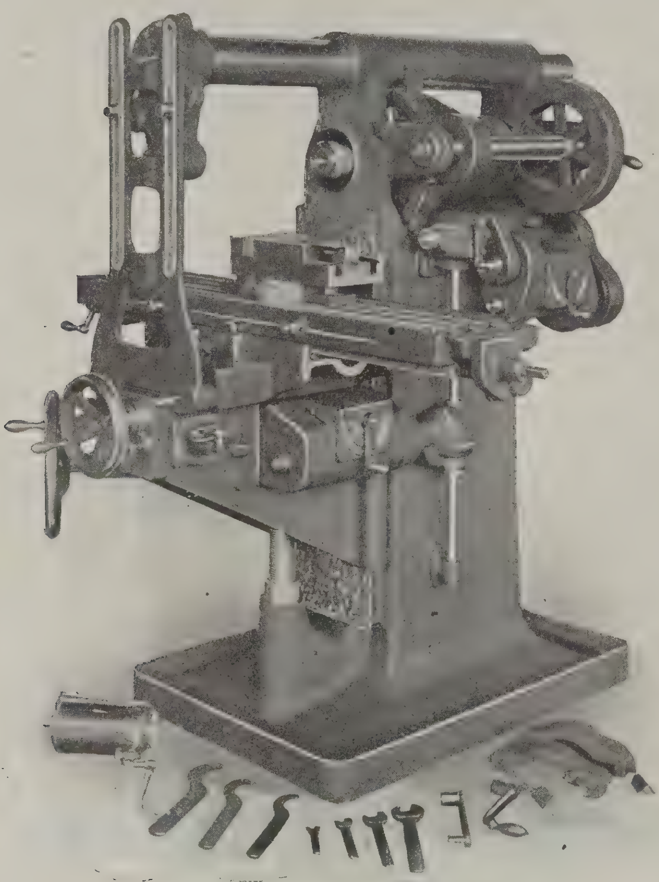
Fig. 2. Drill Similar to that shown in Fig. 1, but Reversible.

been placed on the market; the cut shows the smaller of these two. A good idea of the stiffness and rigidity of the design can be obtained from a study of this cut. It will be noticed that the machine has a geared feed, no chain being used between the spindle and the feed screw, as in former models. The feed changes, of which there are thirty-two, may be obtained while the machine is in motion without the slightest injury to the working parts; the handles for controlling these changes are always in easy reach of the operator, and the feeds are automatic in all directions. The usual telescopic drive is eliminated, being replaced by vertical and horizontal shafts and sliding bevel gears.

The table has a double bearing, being fitted both above and below the dovetailed slide. This tends to keep it in good alignment even when working at the extreme of its motion, at the same time preventing it from cramping, and thus allowing it to work freely. All the gearing throughout the machine

is of steel. The spindle is of crucible steel, running in phosphor bronze boxes provided with means of compensation for wear. The back gears are single in the machine shown, and double in the No. 3-B size, giving respectively 12 and 18 changes of speed with three-step cone and two-speed countershaft. The overhanging arm is of solid steel, carrying an arbor support lined with a bronze bushing.

For the No. 2-B machine shown in the cut, the longitudinal movement is 28 inches; cross feed, 7½ inches; vertical feed, 19½ inches. The largest diameter of the cone is 11⅞ inches and it has four steps for a 3-inch belt. The spindle is bored for a No. 10 B. & S. taper. The net weight of the machine is 2,850 pounds. The dimensions for the No. 3-B machine are as follows: Longitudinal movement, 38 inches; transverse



No. 2-B Owen Plain Milling Machine.

movement, 11 inches; vertical movement, 20¾ inches. The largest diameter of the cone is 12 7-16 inches for a 3½-inch belt. The spindle is bored for a No. 11 B. & S. taper. The net weight of the machine is 4,300 pounds.

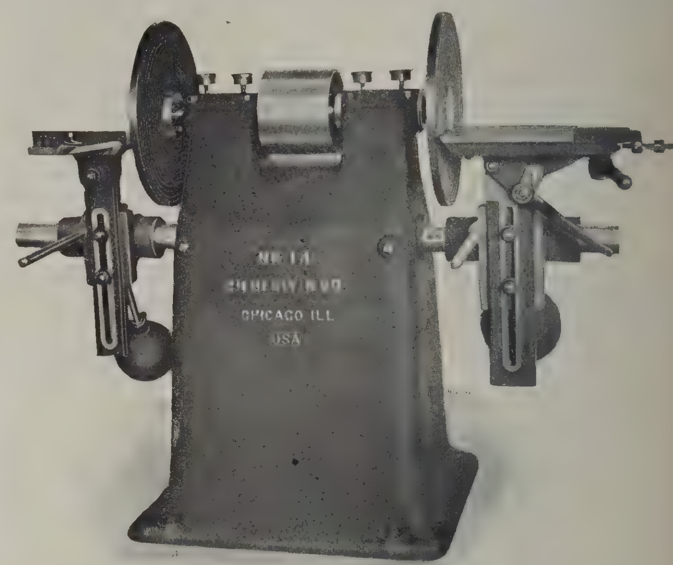
BESLY SPIRAL DISK GRINDER NO. 14.

The disk grinder shown in the cut is built by Charles H. Besly & Co., 15-17-19-21 S. Clinton St., Chicago. This tool is a recent addition to their extensive line of disk grinders. It is a heavy, rigid machine, equipped with lever feed table and strong belt drive, adapted to grinding work in manufacturing quantities. The construction is on a par with that of high-grade machine tools.

The lever feed table bed has T-slots and a key-way for attaching angle plates or other work holders. The table is mounted on a gibbed dovetail slide, and is moved to and from the disk by a lever, pinion and rack, which gives a leverage of 14 to 1. This is a desirable feature as it enables the operator, without undue exertion, to turn out more work by using the abrading disk at its maximum efficiency. The table is equipped with a micrometer stop screw, graduated to read in thousandths of an inch.

The bearing bushings and rocker shaft are turned on the outside, and carefully fitted into bored and reamed holes in the main casting. The end thrust of the spindle is taken between the cast-iron spindle pulley and the flanges of the bronze bearing bushings, on hardened and ground steel collars of large area. The left-hand table carries a detachable bevel gage graduated to 45 degrees. Both tables may be tilted from their horizontal position, and have vertical adjustment and rocking motion, with adjustable counterweights.

The disk wheels are 20 inches in diameter by about 13-16 inch thick, but the machine will swing 23-inch wheels. The

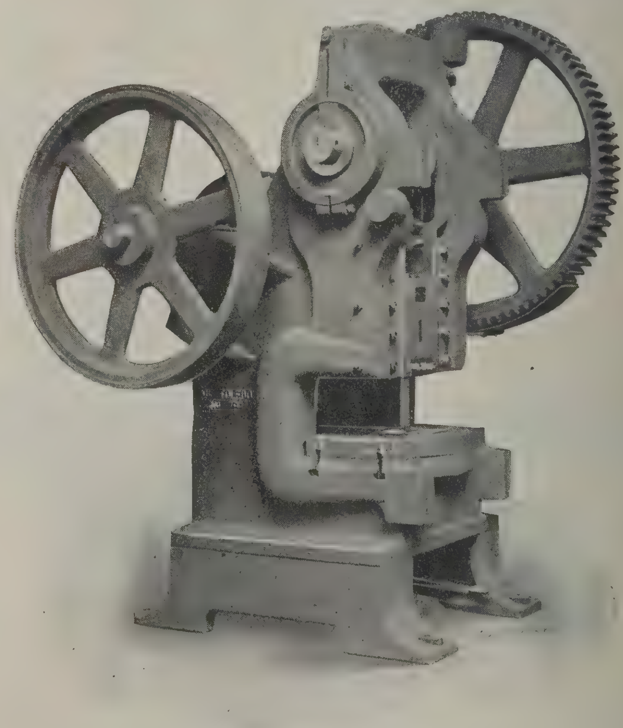


Besly Spiral Disk Grinder.

spindle pulley is 9 inches diameter for a 7-inch belt. The spindle is 2 inches diameter with phosphor bronze split bearings 9 inches long. The rocker shaft is 2¾ inches diameter. The machine, with countershaft and floor press, weighs about 3,000 pounds.

A GAP PATTERN PRESS FOR HEAVY BLANKING.

Large blanks or disks of heavy plate are now being produced in such large quantities that single rotary slitting shears with circling attachments, formerly used for making these disks, are being replaced by presses and blanking



Toledo Gap Pattern Press for Heavy Blanking.

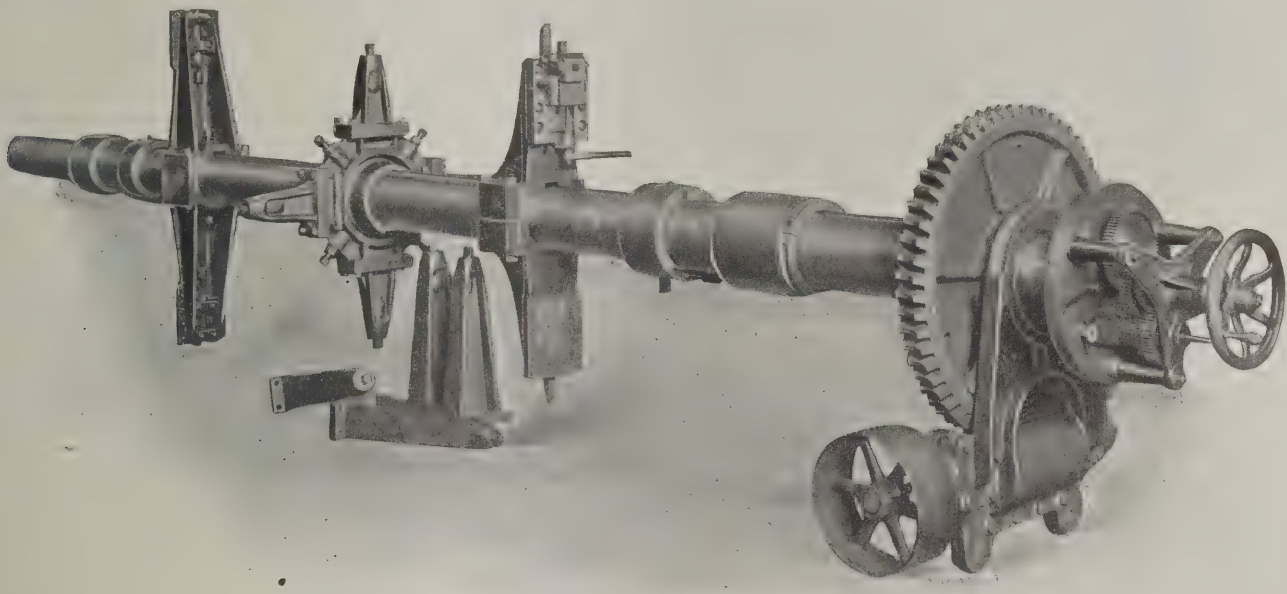
dies. The dies for this work require powerful presses with unusually large bed area and opening. The accompanying illustration shows the design of a new size of geared press with a capacity for cutting large blanks of steel plate up to ⅜-inch; the machine has recently been placed on the market by the Toledo Machine & Tool Co. of Toledo, Ohio. It is much better adapted to the class of work described than the solid back or

other types of press formerly used, and which necessarily had a very limited bed area and opening. The gap pattern is desirable for the convenience of the operator in feeding the heavy plates or bars from which the blanks are made.

This machine has a driving pulley 2 feet in diameter for a 6-inch belt. The balance wheel is 62 inches in diameter and weighs about 1,300 pounds. The gearing reduction is 7½ to 1, the large gear being 61 inches in diameter. The stroke of the particular machine shown is 2 inches, but this can be changed to suit conditions; an adjustment of 4 inches is provided. The distance from the top of the bed to the face of the slide, with stroke and adjustment up, is 13 inches. The bed is 28 inches wide, front to back, and 36 inches long, right to left, with an opening 24 inches wide between the side housings of the frame. The gap extends 8½ inches back of the center line of the slide. The machine weighs about 18,500 pounds.

PORTABLE BORING BAR FOR STEAM TURBINE WORK.

The portable boring bar here described is unusual, in the first place, in the matter of size, though this does not show plainly in the cut on account of the absence of anything with which to compare it. This tool is made for boring up to a diameter of 10 feet, and the bar is 27 feet long. The work for which it is intended is the finishing of the inside surfaces of steam turbine casings or cylinders.



Underwood Portable Boring Bar for Steam Turbine Work

In the process of construction, these castings are first machined at the joint and put together. The shaft openings are then rough bored, the flanges are faced, and the whole thing fastened solidly together, forming a long cylinder to be finished on the inside in a series of varying steps or internal diameters. The bar is inserted through the shaft openings of this long cylinder and carefully centered, being supported by suitable adjustable bushings at these points. Through a manhole in one of the castings the operator now enters and arranges the required boring members and center supports in the interior. These parts are necessarily made in sectional form to permit their being passed in and out through the manhole, and to allow them to be easily handled by the workman. The halftone shows a central support and two boring heads mounted on the bar. The central support has four removable arms, various lengths being used for various diameters; extra parts for this are seen on the floor beneath the machine. The boring heads are made in halves and are arranged to carry two tools diametrically opposite to each other.

In turbines of the type for which this tool is designed, several grooves for the insertion of blades are required to be cut around the circumference of each step in the cylinder. For cutting these grooves, use is made of a supplementary sliding head shown on the upper end of the boring head nearest the right. On the lower end of the same cutter head is shown a place to attach a grinding wheel if necessary, this being used in some cases to finish the blades after they are inserted in the grooves. Finishing boring cuts are also taken by this tool over the blades after they are assembled in the casing. All of the cutting tools for these operations are fastened in place and adjusted by the workman while inside of the casing.

The bar is rotated by an accurately cut worm and wheel of the Albro-Hinley type. The longitudinal feed for the heads is obtained from a screw set within a slot cut in one side of the bar. A similar slot on the other side carries a key, which takes the strain of turning the bar, this strain being in no degree transmitted to the feed screw. The feed screw is rotated by the gearing shown at the head end; three changes may be obtained by operating a push pin. Feeding is accomplished by blocking the hand wheel shown, in any convenient way, the hand wheel serving as well for manual operation of the feed screw.

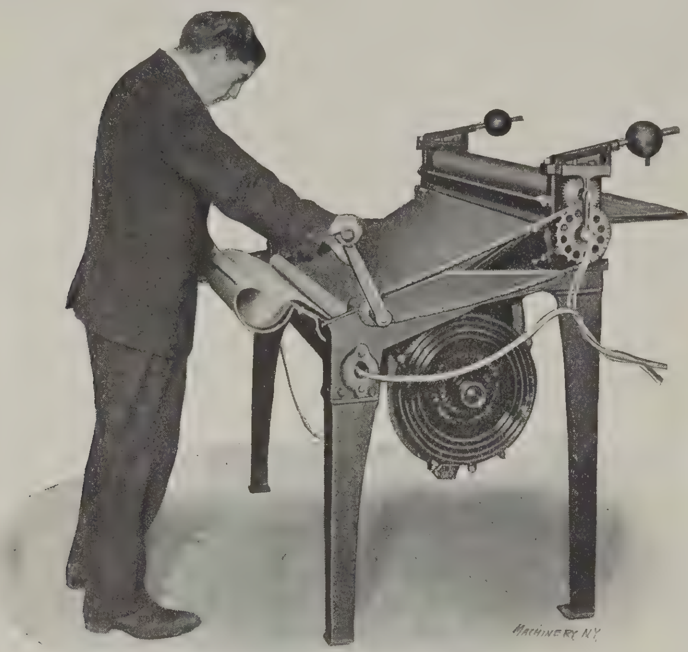
With the increase in the use of the floorplate method of doing heavy work and with the increase in the size of engine and electrical machinery parts, the use of special portable tools has greatly increased. This tool is one example of a number of special devices which H. B. Underwood & Co. of 1025 Hamilton St., Philadelphia, Pa., have been called upon to furnish for engineering establishments engaged in heavy work.

THE CRABB TRANSPARENTIZER.

In the May, 1906, issue of MACHINERY we described a transparentizing machine built by Chas. L. Crabb & Co., 115 Nassau St., New York; this machine was designed for rendering pencil drawings on ordinary drawing paper transparent enough to be used for making blueprints. The cut herewith shows an improved form of the device. It may be operated much more rapidly than the first machine, and has a greater capacity, permitting of the treatment of drawings 42 inches wide and of any length. It will take any thickness of white paper upon which drawings or writing have been made with a pencil or any other ordinary erasable material, and by means of a hot chemical bath and heated calendering rollers render it permanently transparent and waterproof. This operation is a matter of a very few moments only, and from the paper thus treated blueprints can be made immediately, thereby saving the time, labor and expense involved in preparing drawings for blueprinting by the present methods.

A tray which forms a part of the machine contains the solution to be used; this is heated by an electrical resistance coil, wound for 110 or 220 volts. The drawings to be treated are fed into the rolls of the machine and passed through this heated bath by the turning of the crank. After leaving the

bath the sheet is carried by a traveling fireproof apron to heated calender rolls, which squeeze out the surplus liquid, giving the sheet a smooth and dry surface. The operation of the transparentizer is extremely simple and requires no preliminary training or knowledge. It can be operated by a



The Crabb Transparentizer.

boy, at an approximate total cost of two-tenths of a cent per square foot. A saving of 35 per cent in the cost of drawing-office operation is claimed.

* * *

REISSUING DEFECTIVE PATENTS.

The Court of Appeals of the District of Columbia has just rendered a decision which overthrows the views expressed in standard textbooks on patent law, and which should establish a more liberal principle in the reissuing of patents in the future. The statute relating to the reissue of patents has been for the past twenty years construed rather strictly by the Patent Office, so that patent attorneys have looked upon reissues as possible only in the rarest cases. In the present case the applicant was a Frenchman, unfamiliar with American patent law, and not having direct communication with his American patent attorneys. The result was the taking of a patent in this country, which, while it gave to the world a knowledge of a very broad invention—a new and valuable process of melting steel in an electric furnace—did not secure to the inventor the reward which the law contemplates. The patent was limited to a detail of the furnace, and the broad idea of a new process of working the furnace was not claimed. Upon an application for reissue of this patent so as to secure to the inventor claims for the process which he had invented, the three successive tribunals of the Patent Office through which the case was prosecuted refused the reissue, chiefly on the ground that where the patent was originally taken for an apparatus it could not be reissued with claims for a process. This was a theory which had been enunciated in textbooks for a number of years past, and had been held by the Patent Office and apparently acquiesced in by inventors. The present case was appealed, and a decision rendered by Chief Justice Shepard reversing the decision of the Commissioner of Patents, and allowing the reissue with the broadest claims. The court took the view that since the process was described in the statement of the invention of the original patent, although not specifically claimed, the patent might be reissued for the purpose of inserting the claims inadvertently omitted.—*American Industries.*

* * *

Some people are so afraid that a competitor will learn about their business that we sometimes wonder that they sell any goods at all.

INDUSTRIAL NOTES FROM EUROPE.

BRITISH ENGINEERING ACTIVITIES.

Over here there is little change in general conditions. The electrical industries are somewhat hampered by lower prices prevailing, especially in view of the higher prices for raw materials. Manufacturing plants have so multiplied and have been equipped on such modern lines that the competition for electrical contracts of any magnitude is increasingly keen throughout Europe. A number of the smaller concerns which have carefully and gradually extended their operations and equipment appear able, without extreme inconvenience, to compete in several departments with the larger plants at the low prices ruling. In the matter of British industrial organization and methods an interesting departure is to be noted. The employes of the Bradford Dyers' Association recently applied for a 10 per cent advance in wages. As a large volume of business at remunerative prices was being dealt with, it was decided to grant the advance if certain rearrangements of methods—involving a diminution in the number of men employed per unit of output—would be accepted by the workmen. After considerable discussion, the employers' proposals, somewhat modified, were agreed to, on condition that during the first year's operation of the new scheme the proportion of men discharged should not exceed 5 per cent of the number now employed, and that the employers should pay out-of-work benefits to the discharged men at the same rate, and, if necessary, for the same length of time, as paid by the trade union, thus doubling the length of time an unemployed member would be entitled to assistance. This basis of settlement will probably again be heard of in trade disputes touching other industries where improved machinery involves a smaller working force, it being felt that the consequent hardships to the displaced laborers should receive specific consideration during the period of readjustment of working conditions.

Considerable attention is now being paid to the requirements of British commercial men by the board of trade and the consular departments, and important improvements with regard to the methods of supplying prompt and direct information as to foreign markets and requirements, to British manufacturers and merchants, are under way. The question of the compulsory working in Great Britain (either by the patentees or licencees) of patents granted to foreigners is also receiving the careful consideration of the government. In the past the incidence of the present laws, or their administration, has tended to produce a virtual foreign monopoly in certain lines, a quite opposite result to that contemplated by the framers of the law.

Our universities, leading manufacturers and chambers of commerce are now working together much more frankly than formerly with a view to the encouragement and utilization of latent talent. As an instance may be mentioned the "Gartside" scholarship at the Victoria University of Manchester. This, founded in 1902 by a Manchester manufacturer, is open to British subjects of eighteen to twenty-three years of age and is tenable for two years. The first year's work at the university is designed to preface the student so that he may usefully investigate some industry, or part of an industry, in the United Kingdom or abroad. The investigation itself occupies the second year, and to smooth the way the value of the scholarship, which is about $400 per year for time spent in England, is increased to $750 a year for time on the Continent and $1,250 for the United States. An interesting report by the present holder of the scholarship on industrial matters in the United States was recently issued. The matter of location of manufacturing plants receives increasing consideration. Though so comparatively small, the United Kingdom has areas of such diverse character and accessibility by rail or water that periodical surveys of the question of suitable location are desirable. Some inland concerns interested in heavy iron and steel manufactures tend to remove to the seaboard, where possible, in order to diminish the cost of carriage of raw and finished materials—an important item in the total cost of production and marketing. As one of the latest instances in this connection, may be mentioned Cammell, Laird & Co. of Sheffield, who are investigating the

potentialities of Swansea for the establishment of branch works. The opening and working of the Manchester ship canal has also opened out another important industrial district which offers advantages in the way of facilities for handling of railway, barge canal and sea-borne traffic, coupled with a good supply of skilled labor and close proximity to probably the most compact group of manufacturing towns and localities in the world.

A branch of engineering which does not obtrude outside a limited sphere, in which, however, it plays a by no means negligible part, is that of the design, construction and working of modern coke ovens. Our German friends gave a notable lead in the matter of coke-making processes carried out with a view to recovering and utilizing products of distillation formerly practically wasted. These by-products are of considerable commercial value, and though one hears statements that the value to the foundryman of the coke produced by the new process is thus impaired, a shrewd guess may be made that the requirements of the consumers of the coke or by-products will be catered for in proportion to the respective profits accruing from the two products. Some important installations of these coke ovens have been carried out in Great Britain by the firm of Simon-Carves, Ltd., of Manchester, who also undertakes to afterward run the plants, if considered desirable. A kind of side line of this business is the design, erection and supervision of crematories, the company having been pioneer in this direction.

Somewhat allied to this class of work is the design and installation of modern refuse destructors, which are now recognized as pretty well essential to efficient sanitation. The present theory is to, without nuisance, at once destroy all organic matter by exposure to extreme heat—generated by the combustion of the refuse—and thereby raise steam, which is utilized for various purposes, including sewage and water pumping, driving clinker-crushing and mortar-making machinery, generating electricity, etc. As a residual, a vitreous clinker, which is a marketable article in good demand for roadmaking, bacterial sewage filter beds, etc., is produced. The percentage of combustible matter in town refuse varies considerably, being low in country districts where coal is expensive, and comparatively high in manufacturing districts where the domestic use of fuel is, perhaps, somewhat wasteful owing to the English system of open fireplaces. In a number of cases it is found that 1½ pound of water can be evaporated per pound of refuse. In order to obtain such results, the air forced under the fire-bars is preheated by being drawn through regenerator tubes, the outsides of which are in contact with the highly heated gases from the furnace cells on their way to the chimney stack. The feed water for the boilers is also heated by economizers also utilizing the waste gases. In the town of Preston about 1,000 horsepower is daily produced by the destruction of the town's refuse, no nuisance being caused. A good share of the current for running the municipal tram cars is thus provided in addition to the lighting of several administrative buildings. Destructor plants have been erected in many British cities, several on the Continent and in the colonies, and a few, from British designs, in the United States. Concerns prominent in this line are Meldrum Bros., The Horsfall Destructor Co., Heenan & Froude and Manlove Alliot & Co. Messrs. Heenan & Froude, Ltd., Manchester, England, have been commissioned to erect a destructor on Staten Island, New York, to deal with 60 tons of refuse per day of 24 hours, boilers to utilize all the heat generated being also installed.

A rather curious feature in the underground communications of London and New York is the fact that the electrification of the London Metropolitan Railway was carried out by Americans through the instrumentality of Mr. Yerkes, as British electrical engineers found the task too big for them at the time, while the subways under the Hudson are being driven by a British firm of engineers and contractors who, through their unique experience in the utilization of compressed air for tunneling operations, are in a position to effectually cope with the difficulties encountered through the leaky strata of the river bed. James Vose.

Manchester, February 18, 1907.

MISCELLANEOUS FOREIGN NOTES.

Alfred Herbert, Ltd., Coventry, England, has built an automobile engine valve grinding machine in which the valve is rotated continuously in one direction and periodically lifted from its seat, while grinding, by a vertical spindle in the table which is connected to the belt pulley by a crank motion.

Loudon Bros., Ltd., Johnstone, England, have recently completed a horizontal boring and facing machine of large proportions. The bed is 16 feet long; the boring bar, 4 inches in diameter, has a travel of 2 feet 9 inches, and its maximum and minimum distances from top of the two tables of the machine is 24 inches and 6 inches respectively. The machine is built primarily for railway work, and is made to order only.

Motor Car Industry in Great Britain.—During the last year the motor car industry has assumed great dimensions in England, there being at present more than $60,000,000 invested in the British motor car companies, and the value of British cars manufactured during 1906 exceeding $20,000,000. The trade gives employment to a quarter of a million men. The excellent character and popularity of British cars is indicated by the fact that the import of foreign cars decreased during the year by nearly $400,000.

Germany's Export and Import of Machine Tools During 1906.—According to *Zeitschrift für Werkzeugmaschinen und Werkzeuge*, the import of machine tools to Germany last year amounted to 8,574 tons, of which 5,742 tons came from the United States. The exports amounted to 45,241 tons. The imports were nearly 50 per cent larger than those of 1905, and the exports nearly 40 per cent larger than in that year and nearly double those of 1903. Germany's best customers are Italy, Austria and France; Russia, Belgium and Switzerland come in the next place.

Messrs. Drummond Bros., Ltd., Ryde's Hill, England, have recently designed a small 5-inch lathe intended for repairs on motors and motor cars. This lathe is made with considerable accuracy, and high claims are made for it in regard to capacity and power. This lathe differs to a great extent from the usual design of lathes, being at the same time a miniature boring machine with a table similar to that of a Lincoln milling machine. Special features of the lathe render it available for an infinity of operations which could otherwise not be performed without a great number of machines.

Messrs. Ludwig Loewe & Co., Ltd., Farringdon Road, London, have introduced a new drill chuck called the "Grip" chuck. The construction of this chuck is such that the greater the pressure on the point of the drill, the more positive the grip of the chuck. In actual tests, half-inch drills made of high speed steel have been driven with feed and speed resulting in the total collapse of the drill without causing the shank to turn in the chuck. There are no gears or screws in the construction of the chuck, and no key is employed to move the jaws; for this reason it seems as if the makers' claims as to the durability and convenience of the chuck are well founded.

Messrs. Butler & Co., Halifax, England, are building an interesting turning and facing machine. This machine is intended for finishing flywheels at one setting, that is, for turning the face, the rims, the inside and outside of the hub and boring the holes, six tools being in operation at once. The headstock and tool-rests are mounted on a heavy base plate. The face-plate is supported by roller bearings in the headstock. There are six changes of automatic feed. The drive is engaged and disengaged by friction devices. The driving cone and gearing are all designed to give uniform gradations of speed and power. This machine will turn flywheels up to 10 feet diameter and 21 inches wide. The floor space is 22 feet 6 inches by 17 feet.

Automobile Exposition in Germany.—The International Automobile Exposition in Berlin last winter was one of the greatest successes ever attained in this line in Germany. Three hundred and seventy-one firms and manufacturers exhibited their products. Of these 338 were German, while other exhibits were from France, Italy, England, United States, Belgium and Switzerland. Besides automobiles, machines for

the production of automobile parts were exhibited, and Schuchardt & Schütte, of Berlin, exhibited a fine collection of American lathes, screw machines, milling machines, grinding machines, etc., from well-known American firms, among which were the Cincinnati Milling Machine Co., Landis Tool Co., and the Cleveland Automatic Machine Co. There were many motor vehicles of various types for industrial and business purposes exhibited, but considering the great importance of this branch of the automobile industry, a much larger exhibition might have been expected. The reason assigned is that nearly all manufacturers in Germany who are in a position to deliver vehicles are so overcrowded with orders for touring cars, on which they are able to realize a much greater profit than on cars for business purposes, that the latter receive only secondary consideration. The inclination of the manufacturers toward standardizing their motors and the construction of the same in large quantities, together with the fact that new plants are rapidly springing into existence, will probably soon effect a change in this condition of affairs.

The Machine Tool Business in France.—France has not as yet devoted its energies to any great extent to the manufacture of machine tools, and in its many varied industries it uses mostly American and German machines. The imports from the United States are constantly increasing, but there are some complaints in regard to slow delivery and insecure packing. The German trade in France in regard to machine tools is also increasing rapidly, due to the thorough preparation of the German salesmen before they go out "on the road," particularly when they are going to foreign countries. A German salesman gets not only a thorough shop experience, but he is also expected to be well grounded in the principles of machine design, to have worked as an assistant to the inspector testing machines before shipping, and then, if sent to a foreign country, to be thoroughly familiar with the language of the country to which he is sent. The German machine tool builders print their catalogues in several languages, realizing that their own tongue cannot always be depended upon to be understood by the persons whom they want to reach by their trade literature. These points have been accentuated by special agent Arthur B. Butman and may be worthy of consideration. Small tools are manufactured in France and are sold at a lower price than the American-made tools. The latter, however, give better satisfaction and have a good market, the only complaint being of the slow delivery.

* * *

OBITUARY.

R. W. Fuller, the inventor of the machine for making horseshoes, died March 11 at Hanover, Conn., aged 85 years. It is claimed that Mr. Fuller's invention was copied by others who made millions of dollars through it, but the inventor died a poor man.

O. D. Munn, one of the two original publishers of the *Scientific American* in its present form, died February 28 at his home in Llewellyn Park, Orange, N. J., aged nearly 83 years. Mr. Munn and his partner, A. E. Beach, who died about eleven years ago, acquired the *Scientific American* in 1846 and made it the organ of their patent business which grew to great proportions, over 100,000 patents having been taken out through this firm alone. The profession of the patent lawyer sixty years ago was nearly unknown, and the concern was, in a sense, a pioneer. The work of the partners brought them in intimate contact with many of the famous inventors of the past era.

HARRY C. HOEFINGHOFF.

Harry C. Hoefinghoff, president and general manager of the Bickford Drill and Tool Co., Cincinnati, Ohio, died on March 2 from an operation performed a few days earlier for appendicitis. Mr. Hoefinghoff was thirty-five years of age, and had been president of the company since 1899, when he succeeded his father, who was also one of the owners of the Hoefinghoff & Lane Co., an old-time Cincinnati foundry business. Mr. Hoefinghoff was one of the leading young business men of Cincinnati, but his acquaintance was not confined to that city, being extended over the entire country, especially among the machinery and kindred trades, his genial disposition and kindly ways having made him many warm friends outside of his immediate circle, to whom his untimely death comes as a personal bereavement. He was an active member of the National Machine Tool Builders' Association, the Manufacturers' Club, Business Men's Club, and the Cincinnati Factory Colony Co. at Oakley, Ohio, where arrangements have been made to establish a large plant for his company.

Harry C. Hoefinghoff.

Mr. Hoefinghoff saw the Bickford Drill and Tool Co. grow under his management from a comparatively small concern, until at the time of his death it was the largest manufacturer of radial drills in the world. This success was due not alone to his energy and good judgment, but to the progressive ideas which he carried out, and the quick utilization of methods that appealed to him as being practicable, and which would improve his product or lessen its cost.

Mr. Hoefinghoff leaves a widow and three children, one boy and two girls.

* * *

PERSONAL.

E. M. McIlvain, formerly president of the Bethlehem Steel Co. has been elected president and general manager of the Robbins Conveying Belt Co., New York.

J. F. W. Bunsen, nephew of the late Prof. Bunsen, the inventor of the burner bearing his name, lately entered the employ of Muralt & Co., engineers and contractors, New York, and will take charge of their Southern office in Charleston, S. C.

W. J. Dolan, formerly connected with the Remington Typewriter Co. and later with L. C. Smith & Bros., Syracuse, N. Y., has accepted a position in the sales department of the Dayton Pneumatic Tool Co. and will have his headquarters in Pittsburg, Pa.

H. D. MacDonald, chief draftsman of the tool designing department and assistant master mechanic of the J. I. Case Threshing Machine Co., resigned his position, and on March 1 became connected with the International Harvester Co. on automobile construction work.

* * *

The dedication of the new Engineering Societies Building, New York, in which are housed the three founder societies, namely: American Society of Mechanical Engineers, American Institute of Electrical Engineers and the American Society of Mining Engineers, will be held April 16 and 17. The dedicatory program will include a joint meeting of the three societies at which there will be addresses by the presidents of the respective societies, and the reading of greetings from sister societies all over the world. Opportunities will be afforded for visiting plants of engineering interest in New York and vicinity, as is customary at the annual meetings of the A. S. M. E.

The date of the spring convention of the National Machine Tool Builders' Association, which is to be held at Fortress Monroe, Va., has been changed to May 14 and 15. The Hotel Chamberlain is the headquarters.

* * *

FRESH FROM THE PRESS.

STATISTICS OF RAILWAYS IN THE UNITED STATES FOR THE YEAR ENDING JANUARY 30, 1905. The 18th annual report of the Interstate Commerce Commission. 728 pages 6 x 9 inches. Published by the U. S. Government, Washington, D. C.

AIR BRAKE CATECHISM. By Robert H. Blackall. 375 pages, 5 x 7 inches. 131 cuts. Published by Norman W. Henley & Son, New York.

This book is of the 21st edition, and is revised and enlarged. Mr. Blackall's work is so well known that a comprehensive review is unnecessary. It is a standard work on the air brake and is gotten up in the popular catechism style so well known in connection with educational books of this class. The book includes a pocket in which are three folding plates, and accompanying the book are two additional charts, one showing the modern Westinghouse high speed and signal equipment for freight service. To railroad men and others interested in the principles and operation of the air brake Mr. Blackall's work may be heartily recommended.

HENLEY'S 20TH CENTURY BOOK OF RECIPES, FORMULAS AND PROCESSES. Edited by Gardner D. Hiscox. 787 pages 6 x 9 inches. Published by Norman W. Henley & Son, New York. Price, bound in cloth, $3.00

This book contains nearly 10,000 selected scientific, chemical, technical and household recipes. It represents an enormous work in mere labor of compilation to say nothing of the work of editing. The list of subjects includes gilding, galvanizing, bronzing, tinning, silvering, plating, enamelling, varnishing, polishing, soaps, amalgams, alloys, solders, photographic formulas, lubricants, oils, inks, tanning, waterproofing, fireproofing, and many others too numerous to mention. The value of a reliable compilation of general formulas of the general character outlined above is too plain to need further comment.

QUESTIONS AND ANSWERS FROM THE GAS ENGINE. 277 pages, 5 x 7 inches. Published by the Gas Engine Publishing Co., Cincinnati, Ohio. Price $1.50.

This little book was compiled from the "Answers to Inquiries" column of the *Gas Engine* and includes the more interesting and valuable questions and answers that have been published in that journal for the past eight years. These inquiries relate to design, construction, operation and repair of gas and gasoline engines for stationary and automobile use, and in some instances are illustrated. An index facilitates the finding of any particular subject. The book should be of value to automobilists, motor boat users and the large general class of gas engine users throughout the country, a class that is rapidly increasing as the merits of the small internal combustion engines are recognized.

CONCRETE FACTORIES. Compiled by Robert W. Lesley. 152 pages 6½ x 9¾ inches, fully illustrated. Published for the Cement Age Co. by Bruce & Banning, New York. Price $1.00.

The work consists of a series of papers descriptive of the use of cements and concrete as applied to the construction of factory buildings. The book offers in condensed form the most complete review of the principles underlying reinforced concrete construction that has yet been published and it has the advantage of being presented in a way that is understandable by the layman as well as by the engineer. The work is a compilation of papers by men who have made a special study of the subject and the names included are Messrs. Walter Mueller, E. A. Trego, Henry H. Quimby, Emile Perrot, A. C. P. Turner, E. P. Goodridge, J. R. Worcester, Dean & Main, and other eminent authorities on concrete construction work.

THE RAILROAD POCKETBOOK, by Fred H. Colvin. 215 pages, 4 x 6 inches, illustrated. Published by the Derry-Collard Co., New York. Price $1.00.

This little book is a quick reference cyclopedia on railroad information. The subjects are arranged alphabetically; some are very briefly defined and others are given considerable space, according to the importance of the subject. It has been the aim to compile and define a list of subjects that occur most in railway work, and the definitions are not limited to word descriptions alone, but frequently are illustrated as well. For example, types of locomotive boilers are represented by a number of outline drawings and the same applies in general where the subject may be illustrated advantageously. The book is one that railway men will find convenient. It contains a number of valuable tables including weights of tires, tire shrinkage allowance, tire turning chart, etc., and is of a size that can be carried in the pocket without trouble. The work has not been paged consecutively but has been made up so that new matter can be added from time to time as conditions require. It is the intention of the publishers to keep the book up to date and to make it a complete pocket cyclopedia so far as possible within its field.

ANNUAL REPORT OF THE SMITHSONIAN INSTITUTE FOR THE YEAR ENDING JUNE 30, 1905. 576 pages, 6 x 9 inches, illustrated with over 100 engravings. Published by the United States Government, Washington, D. C.

The annual report of the Smithsonian Institute for a number of years has been a bulky volume, containing an account of the work accomplished by the Institute, its receipts and expenditures, and a voluminous compilation of scientific articles taken from various sources. The same general plan has been followed in the present report but the number of abstracted articles is considerably reduced so that the bulk of the work is considerably less than in former years. The abstracted reports include "New Measurements of the Distance of the Sun" by A. R. Hinks; "Photographing Lightning with a Moving Camera" by Alex. Larson; "The Tantalum Lamp" by W. VanBolton and O. Feuerlein; "Some Refinements of Mechanical Science" by Ambrose Swasey; "Progress in Radiography" by L. Gastine; "History of Photography" by Robert Hunt; "The Genesis of the Diamond" by Gardner F. Williams; "Gold in Science and in Industry" by G. F. Beilby; "Submarine Navigation" by William H. White; "Liberia" by Harry Johnston; "Geographic Result of the Tibet Mission" by Frank Younghusband; etc.

BULLETINS OF THE ENGINEERING EXPERIMENT STATION, UNIVERSITY OF ILLINOIS. Volume 1, including bulletins Nos. 1 to 8 and circulars 1 and 2. 6 x 9 inches. Published by the University of Illinois, Urbana, Ill.

The bulletins contained in Volume 1 are "Tests on Reinforced Concrete Beams," by Arthur N. Talbot; "Tests of High Speed Steels on Cast Iron," by L. P. Breckenridge and Henry B. Dirks; "The Engineering Experiment Station of the University of Illinois," by L. P. Breckenridge; "Tests of Reinforced Concrete Beams, Series of 1905"; "Resistance of Tubes to Collapse," by Albert P. Carman and Morris L. Carr; "Holding Power of Railroad Spikes," by Roy I. Weber; "Fuel Tests of Illinois Coal," by L. P. Breckenridge, S. W. Parr and H. B. Dirks; "Tests of Concrete: I. Shear, II. Bond," by Arthur N. Talbot. These bulletins are without doubt the most valuable ever issued by the engineering department of a technical institution. They represent original investigation of a high order and the work is worthy of substantial encouragement. The bulletin of tests on high-speed tool steels on cast iron contains the first published tests of consequence that had been made in this country. Recent papers of technical interest are those on the resistance of tubes to collapse, and the tests of concrete and reinforced concrete beams. The engineering experiment station, it may be explained, is a department connected with the college of engineering. It was established in 1903 for the purpose of carrying on investigations along various lines of engineering, and for the study of problems of importance to professional engineers and to the manufacturing and industrial interests of the State.

MODERN AMERICAN LATHE PRACTICE. By Oscar E. Perrigo. 424 pages 6 x 9 inches. 314 illustrations. Published by Norman W. Henley & Son. Price $2.50.

The aim of the author was to present within a single volume the history and development of the lathe—the universal machine tool—with particular reference to the American designs and types. The author is peculiarly fitted to write an intelligent and well-thought out work of this character, both by reason of literary ability and his experience as a practical lathe builder, having been for a number of years superintendent of one of the oldest machine tool building concerns in New England. The first chapter is historical and traces the lathe from the earliest known times to the introduction of screw threading. In this chapter such devices as the spring-pole lathe, fiddle-bow lathe, foot-power lathe and other types that belong to the era before the advent of the steam engine are described and illustrated. It is from the spring-pole or "lath" used in the primitive machine for converting the reciprocating motion of the foot into rotary motion that we get the present name "lathe" applied to turning machines as a type. That the work is comprehensive is indicated by the headings of the following chapters, to wit: History of the Lathe up to the Introduction of Screw Threads; The Development of the Lathe Since the Introduction of Screw Threads; Classification of Lathes; Lathe Design: the Bed and its Supports; Lathe Design: the Head-stock Casting, the Spindle and the Spindle Cone; Lathe Design: the Spindle Bearings, the Back Gears and the Triple Gear Mechanism; Lathe Design: the Tail-stock, the Carriage, the Apron, etc.; Lathe Design: Turning Rests, Supporting Rests, Shaft Straighteners, etc.; Lathe Attachments; Rapid Change Gear Mechanisms; Lathe Tools, High-Speed Steel, Speeds and Feeds, Power for Cutting Tools, etc.; Testing a Lathe; Lathe Work; Engine Lathes; Heavy Lathes; High-Speed Lathes; Special Lathes; Regular Turret Lathes; Special Turret Lathes; Electrically Driven Lathes. The publisher has departed from the common practice of borrowing halftone electrotypes from the various makers of the tools illustrated, and has, instead, used line cuts throughout, thereby giving the book an individuality and tone that too often is sadly lacking in books of this character.

NEW TRADE LITERATURE.

D. SAUNDERS' SONS, Yonkers. N. Y. 1907 illustrated catalogue containing descriptions and price lists of pipe-threading machinery.

PITTSBURG AUTOMATIC VISE & TOOL CO., Pittsburg, Pa., has issued a set of unique blotters advertising their automatic vises.

NORTON GRINDING CO., Worcester, Mass. Leaflet announcing the Boston Automobile and Power Boat Show, March 9 to 16, at which the company exhibited specimens of ground crankshafts.

THE UNIVERSITY OF ILLINOIS, Urbana, Ill., has issued a leaflet giving information concerning the school of railway engineering and administration recently organized.

B. F. STURTEVANT CO., Boston, Mass., has issued Bulletin 125 describing and illustrating Class V S 5 vertical engines. Tables giving the principal dimensions and net horsepowers are included.

THE ROBERTSON MFG. CO., Buffalo, N. Y. 1907 Catalogue describing and illustrating various types of Robertson rapid cut power saws. Copy of the catalogue will be sent to all interested.

JEFFREY MFG. CO., Columbus, O. Bulletins illustrating coal and ashes handling machinery and grab bucket system, showing the machines installed in a number of plants.

L. H. GILMER & CO., Philadelphia, Pa. Catalogue No. 3, describing Gilmer endless belts, polishing machines and attachments, abrasive wheels, grinding materials, etc.

THE NILES-BEMENT-POND CO., Trinity Building, 111 Broadway, New York, in its *Progress Reporter* for March, 1907, describes a Pratt & Whitney 16-inch toolmakers' lathe, some special planers, pneumatic clutches for planer drives, armor plate machinery, etc.

THE ELECTRIC CONTROLLER & SUPPLY CO., Cleveland, O. Bulletin No. 107 on Type G controllers describes details of construction and operation, and contains instructions for ordering, price list and other tables of specifications.

NILES-BEMENT-POND CO., Trinity Building, 111 Broadway, New York. List No. 13 of second-hand metal-working machinery, among which is included railroad machinery, screw-cutting lathes, planers, shapers, drills, milling machines, grinding and polishing machines, etc.

CLEVELAND CITY FORGE & IRON CO., Cleveland, O., has published a book designed to set forth some of the manufactured products of the company. It also contains useful tables giving information relating to round and square bars and their connections. The book will be of value to engineers and builders.

THE NATIONAL ASSOCIATION OF MANUFACTURERS, New York, has sent us a pamphlet explaining what the association tries to be and what it tries to do for manufacturers. It explains the workings of the home and foreign departments, and concludes with a list of officers and directors of the association.

MONTGOMERY & CO., 105 Fulton Street, New York City. Tool catalogue No. 25, giving net prices printed in red ink. Specifications and illustrations of some of this company's many classes of tools are included. Prices of any tools not included in these pages will be submitted upon request.

JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J., has issued an artistic book entitled Crucibles—Their Care and Use. The purpose of this book is to inform the user of crucibles as to their nature and characteristics, and give him suggestions as to their care and handling. It gives much information on graphite and graphite crucibles, describes various fuels used in melting metals, gives the proportions of metal in commonly-used alloys, tells the freezing, fusing and boiling points of various substances and the specific gravity of various metals, and other allied information. All those interested in the melting of metals should obtain a copy of this book.

THE AMERICAN LOCOMOTIVE CO., 111 Broadway, New York City, has recently issued a pamphlet which illustrates and describes light locomotives (both steam and compressed air) adapted for the use of contractors, mines, logging roads, plantations and industrial plants, and for a wide range of service on light rails and poor road bed. The pamphlet contains 31 illustrations of different designs and types, and on the page opposite each illustration is a table giving the principal dimensions of designs of progressive weights and hauling capacities of the type illustrated. The last part of the pamphlet is devoted to engineering data and contains a number of very useful tables and formulas. The pamphlet is a complete record of the production of the company in locomotives of light power.

CONTENTS FOR APRIL.

One feature of broad interest in the April *Century* is a popular presentation of color blindness with special reference to art and artists, and incidentally to railway employes. The writer, Dr. Edward A. Ayers, also touches on some of the humorous happenings incident to the waywardness of human vision. Outside of this there are a number of interesting short stories, and a continuation of the serial story, "The Shuttle." Much of the present issue is devoted to unusual features dealing with subjects of natural history and with tales of ancient ruins.

MANUFACTURERS' NOTES.

Champion Tool Works Co., 2422 Spring Grove Ave., Cincinnati, Ohio, manufacturer of lathes, is building an addition to its present shop.

Walcott & Wood Machine Tool Co., Jackson, Mich., is the successor to Geo. D. Walcott & Son. The president of the new concern is Mr. E. E. Wood.

Cincinnati Shaper Co., Garrard Ave. and Elam St., Cincinnati, Ohio, will make a large addition to its present plant. The addition includes a new warehouse.

M. Koyemann, Düsseldorf, Germany, states that he has made an agreement with the Windsor Machine Co., Windsor, Vt., to sell its Gridley automatic turret lathes in Germany.

Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, is making a large addition to its present plant and is adding another power station; 65 new machine tools are being installed.

Sterling Electric Motor Co., Dayton, Ohio, has broken ground for a new factory located at the corner of Second and Clinton Sts. The factory building and office will cover one entire block.

The Star Corundum Wheel Co., Ltd., Detroit, Mich., is now located in its new factory, 241-251 Cavalry Avenue, where it has a very complete equipment for the manufacture of abrasive wheels.

The Link-Belt Co. has acquired a new office location at 84 State Street, Boston, Mass., from which the future business of its chain drive department in New England will be directed.

The Bullard Machine Tool Co., 531 Broad St., Bridgeport, Conn., has recently appointed the Pacific Tool & Supply Co., 556 Howard St., San Francisco, agents for its product in California.

Illmer & Co., Cincinnati, Ohio, have opened an office at 310 Fourth National Bank Building where they will conduct a consulting business as gas engine experts, specializing in oil engines and high power gas engine design.

The Hisey-Wolf Machine Co., Cincinnati, Ohio, has purchased a plot of ground at the corner of Canal and Township Sts., where it will erect a new factory 165 x 245 feet, three stories high. The company expects to occupy the entire building.

Charles H. Besly & Co., 15-17-19-21 South Clinton St., Chicago, Ill, exhibited their Besly disk grinders and hand polishing wheels at Liege Exposition last year, and have been awarded medals for their exhibits.

The United States Census Bureau, Washington, D. C., is developing an extensive machine shop for experimental purposes, and often has occasion to consult catalogues of various manufacturers of machine tools, small tools, etc. The Bureau solicits all manufacturers of machine tools, etc., to send their catalogues for filing.

The S. Obermayer Co., Cincinnati, O., has made contracts for improvements for its plant on the western side of Evans Street, south of Eighth Street. The improvement consists of a two-story brick building 75 x 75 feet for manufacturing purposes and in which will be installed a 500-horsepower Greenwald Corliss engine with improved rope drive.

Williams, Brown & Earle, 918 Chestnut St., Philadelphia, Pa., have received a special order from the Baldwin Locomotive Works, whose entire blueprint plant was destroyed by the great fire of January 29, for a Williams, Brown & Earle perfecting machine arranged to print, wash, potash and dry blueprints at the rate of 12 to 15 square feet per minute and to deliver same ready for use.

The Electro Metallurgical Co., 157 Michigan Avenue, Chicago, Ill., was incorporated about six months ago and began the manufacture at Niagara Falls of high-grade ferro-alloys; is is now installing additional equipment there for materially increasing its output. This business includes that of the Willson Aluminum Co., Kanawha Falls, West Virginia, which was transferred to it in February. The New York offices are located at 79 Wall Street.

Ph. Bonvillain & E. Ronceray, Paris, France, will exhibit their molding machines at the meeting of the American Foundrymen's Association to be held in Philadelphia, May 20 to 24. Mr. E. Ronceray will take charge of the exposition, leaving Havre for the United States April 13. While here he will visit the principal machine tool manufacturers with a view of establishing connections for the sale of American machinery in Europe.

The American Blower Co., Detroit, Mich., has recently completed a large addition to its steel plate fan shop, and a large addition to its power plant and engine construction department is under way. Since putting the new vertical self-oiling engine on the market, the engine department has developed so greatly as to force an entire rearrangement of the plant.

The Samuel C. Tatum Co., Cincinnati, Ohio, is about to erect a large factory building 366 feet long, four stories and basement; also a foundry building 110 x 300 feet, with power plant, etc., to properly care for the large increase in its business. Since its establishment in 1859 the concern has been at John and Water Streets, but the new location is Colerain and Monmouth Avenues.

The Scranton & Co., New Haven, Conn., manufacturers of the Scranton improved upright power hammer and other specialties, have increased their manufacturing capacity in order to take care of their rapidly growing business. They expect soon to have all orders delivered complete and to accumulate a stock from which future orders can be promptly shipped.

The Fox Machine Co., 815-825 No. Front St., Grand Rapids, Mich., recently shipped good sized orders of machine tools, pattern shop equipment and general woodworking machinery to Japan, Italy and France. The company is constantly receiving small orders from nearly every civilized country on the globe. Domestic trade is held up very strong; its plant is running twenty-two hours per day and has been doing so for six months past.

The G. M. Yost Mfg. Co., Mechanicsburg, Pa., has moved its plant from Yonkers, N. Y., and its office from Waynesboro, Pa., to the above location. The company has secured a charter and is organized with the following officers: President, I. E. Yost; vice-president and general manager, G. M. Yost; secretary and treasurer, T. J. Kennedy. The company will manufacture a complete line of the Stevens and Snediker quick-acting vises, and in addition a full and complete line of regular machinists' vises.

The Hisey-Wolf Machine Co., Cincinnati, Ohio, manufacturers of portable electrical drills and grinders, has increased its capital stock to $100,000. The increase is to provide additional facilities to handle their rapidly growing business. This company enlarged its present factory about two years ago but has again outgrown it and will build an up-to-date plant, giving employment to about two hundred people.

The Northern Engineering Works, 26 Chene St., Detroit, Mich., crane manufacturers, is building an addition to its plant consisting of a one-story erecting building, 50 x 100 feet, in which electric crane trolleys will be built. This building will be served by a 10-ton electric traveling Northern crane. Another addition is a two-story building 30 x 50 feet which will serve as toolroom and storeroom. Both buildings are of brick and steel construction with saw-tooth roofs.

The Independent Pneumatic Tool Co., Chicago, Ill., has received a large order for "Thor" piston air drills and pneumatic hammers from the Wisconsin Engine Co., Corliss, Wis. The engine company made an exhaustive test extending over three months and including every make of pneumatic tools on the market. The awarding of the contract to the Independent Pneumatic Tool Co. is considered to be indorsement for greater efficiency and durability of the "Thor" tools than any of their competitors.

J. M. Carpenter Tap & Die Co., Pawtucket, R. I., broke ground for its new factory on March 19, 1907. The building will be of brick construction, practically fireproof, covering 24,000 square feet of floor space, and increasing the company's manufacturing facilities seventy-five per cent. By means of these increased facilities the company expects to be better able to serve its patrons and to fill promptly all requirements in its line of tools for cutting screw threads. This company started in business thirty-seven years ago and is the pioneer machine screw tap maker of this country, having first put the machine screw tap on the market.

de Fries & Cie, Akt.-Ges., Düsseldorf, Germany, had a prosperous business in 1906, the amount of sales showing an increase of 50 per cent as against 1905. The concern now employs nearly 900 people. Besides manufacturing machines of their own design, this concern is still importing large quantities of American machine tools, and it expects to increase American connections. The stock and showrooms have been considerably extended. In Milan it has without doubt the most beautiful showroom on the best site in that city, and a new showroom has been opened in Paris.

The Ohio Foundry Co., Dayton, Ohio, has organized a railroad company for the purpose of acquiring track facilities, and a charter has been granted for it under the name of the Ohio Sterling Railroad Co. The proposed switch will run into the new plant now being constructed. The machine shop is 110 feet by 168 feet with saw-tooth roof construction, brick walls and gravel roof. Part of the building will be two stories high. This building will be occupied by the motor shop. The foundry building will be 140 feet x 260 feet, and is to be a brick structure with wooden framing and gravel roof. The president

RAILWAY MACHINERY.

A special edition of MACHINERY devoted to Locomotive and Car Equipment and Mechanics.

May, 1907.

GASOLINE MOTOR CARS FOR RAILWAY SERVICE.*

WE have, in pumping and coaling stations, stationary gasoline engines that are delivering power at a cost of 1.56 cent per horsepower hour for fuel; this, as compared with 1.92 cent per horsepower hour for steam power. There is no logical reason why this very economical power cannot be utilized for operating a transportation medium on an isolated railroad line. Furthermore, the electric lines have demonstrated that large profits result from the economical operation of self-propelled cars. These electric lines, with their frequency of service and ability to handle a large number of passengers, when brought into competition, take all the steam railroad's passenger business.

Need of Small Units for Steam Railway Passenger Service.

The carrying of passengers and freight by means of small units like motor cars, together with the frequency of service afforded, seems to meet with the approbation of the general public, and it is due to this fact that we find a general demand for a self-propelled car to operate on steam railroads. I do not believe steam power for motor-car service will ever be economical. Experience is a very good teacher; the experience in past years in operating the steam dummy has always resulted in a discontinuance of the service, and generally the bankruptcy of the company or individual operating same. Steam dummy service is and always has been inviting; yet, in the face of the many failures in the past, even under favorable conditions, there has not been sufficient advancement or improvement made in the utilization of the steam power of to-day to insure the success of the steam motor car.

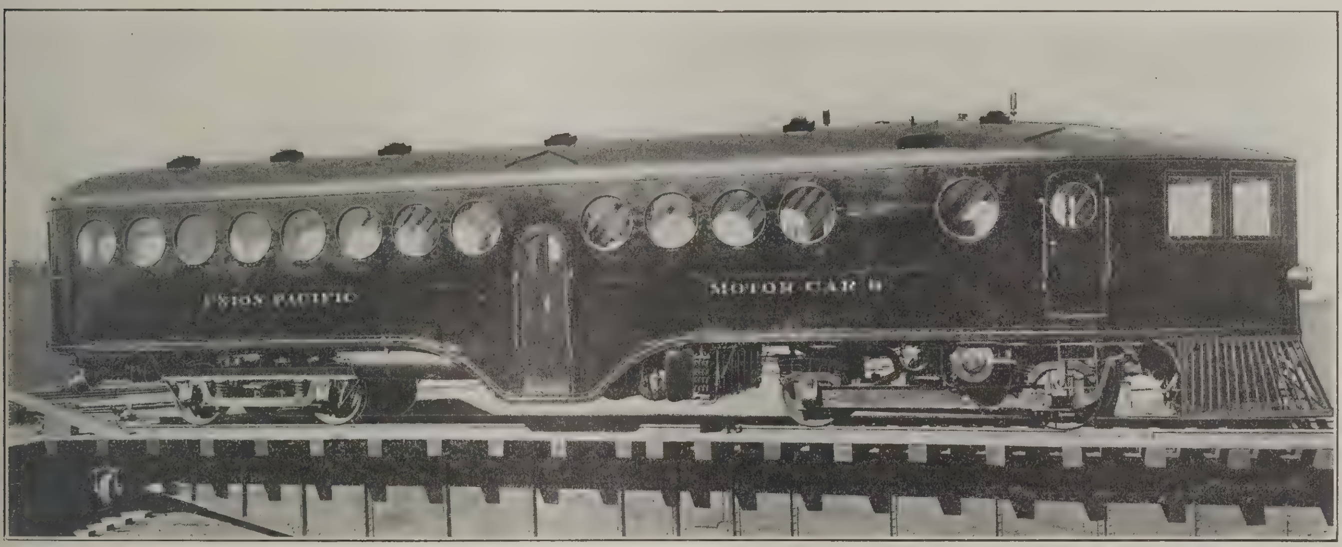


Fig. 1. Union Pacific Gasoline Motor Car No. 8.

Steam Motor Cars Unfit.

The modern locomotive and steam motor car, with high steam pressure and the attendant flue and firebox troubles—the troubles due to formation of scale, broken staybolts, leaky front ends, defective draft, poor coal and kindred necessary evils incident upon the use of a separate power-generating unit, such as a boiler entails—are much more complicated and vulnerable pieces of machinery than the gasoline motor car in which, technically speaking, there is nothing present but (1) vehicle, (2) prime mover, and (3) transmission, the complicated generator with its attendant multitudinous parts likely to give trouble being absent here. It necessarily and logically follows, to a mechanical mind, that a gasoline motor car, properly constructed and built with the same skill and care as a locomotive, is a much less vulnerable machine than a locomotive, and will undoubtedly give more continuous service without failures.

There is a great demand for a low-cost-of-operation, self-propelled passenger car; there are several kinds of transportation service to which the gasoline motor cars are particularly well adapted, and to which they are almost a necessity; many steam passenger trains are being operated at a financial loss, yet the passenger service must be maintained. To meet these demands it seems necessary, in the present advance of civilization, that gasoline motor cars be designed for use particularly on steam railroads.

Branch lines collect freight traffic and feed the main line, and the limited passenger business, of course, can be handled economically when turned over to the main line. Thus it is, if the steam train could be replaced by a combination motor car, a great saving could be made in the operating expenses. Passenger traffic which would be insufficient to fill a steam train in most cases would justify the operation of a gasoline motor car. Frequency of service could be given the public, which, of course, is much appreciated. The number of trips, cost of operation, etc., is entirely dependent upon the density of traffic and the length of the branch line. Now, on steam railroads in direct competition with the frequent service of electric lines, a motor car of high power is necessary to obtain the rapid acceleration and high speed required for this class of service. However, with these high-power engines there seems to be no particular increase in the cost of operation, as larger engines work more economically per horsepower developed than the smaller ones. These cars are an entirely new style of transportation medium, and should be constructed, not along the conventional lines of an electric car, a steam passenger coach or railroad locomotive, but should be designed on entirely new lines; in other words, on lines particularly adapted for this new class of service.

Design of Car Body.

In designing the car body of the motor car, three points must be considered: *viz.*, weight, cost and strength. For years, in steam car construction, the tendency has been toward a more elaborate interior finish, additional conveniences and numerous other improvements, all of which have added materially to the weight; the length of cars, large

* Abstract of Paper by W. R. McKeen, Jr., read before the New York Railroad Club, April 19, 1907.

windows, improved couplers, improved draft rigging, trucks, air brakes, etc., have also increased the dead weight of the car, each ton of added weight making the cost of hauling passengers more expensive. As a result of this our trains and locomotives have become so heavy that in case of a collision the cars are subjected to such severe shocks that they collapse and in many cases telescope and go to pieces.

Now that the old conventional type of transportation vehicles is to be discarded and an innovation started, it seems logical that we should take advantage of the vast experience in building steam cars and include in this new design all the recent demands for improvements in our steam cars. I particularly refer to the demand for transportation vehicles that will insure the safety of passengers occupying same should the car get into a wreck or turn over. Therefore, in evolving a design of motor car, I thought it absolutely essential to use steel only. A motor car operated in connection with steam train service will, at times, be subjected to severe shocks, and it has been my idea to design a car of steel that would be susceptible to any sort of a shock without danger of collapsing or telescoping. With the ocean liners of ponderous weight a collision will result in a hole being punched in the side of the vessel, but, as a rule, the other parts of the frame will not be damaged; many valuable ideas may be drawn from the experience obtained in modern shipbuilding. Instead of

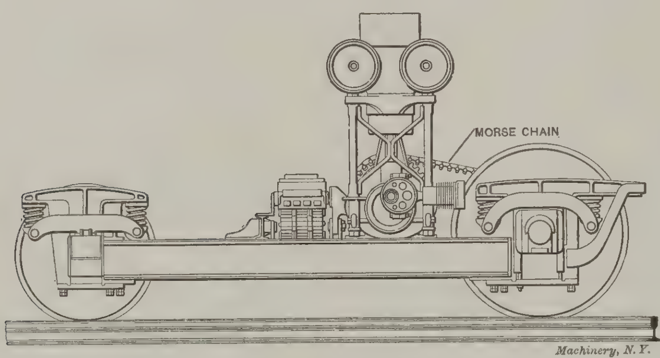


Fig. 2. Side Elevation of Union Pacific Motor Truck for Gasoline Car.

having an underframing of excessively heavy sills with a light cracker-box framing above, we have endeavored to make the whole car body a unit structure, heavy parts of which brace its adjacent members, and in case of a wreck every bit of steel in the car would be utilized in offering resistance to same. Thus, our underframing comprises but one moderately heavy center sill; the side sill is a light-weight continuous channel extending around the body of the car. From this outer channel bar we have continuous steel ribs running up the side through the roof and down the other side of the car; these are braced to each other by suitable cross braces. The sides of the car form a truss; the plate of the car being the top chord and the sill being the bottom chord. This framing is well tied together at all points, and is further reinforced and strengthened by the sheet steel covering. The ends of the car are enormously strengthened by the round shape at the rear and the pointed lines in front. In a collision this car could be punctured or bent, but it could not be telescoped. The latest design of car, with metal frame round windows, enables the diagonal braces of the steel frame to be brought very close to top of car, and by lowering the roof and bringing the plate of car closer to the side sill we get an enormous increase in the strength of the car side, and the side of the car comes more nearly to the form of a girder.

Air Resistance.

(From the Berlin-Zossen Test of 1902.)

The test conducted with the car having 97 square feet of flat end surface, the air resistance was as follows:

At 25 miles per hour, 2.5 pounds per square foot.
At 50 miles per hour, 8.2 pounds per square foot.
At 62 miles per hour, 12.6 pounds per square foot.

No figures are given for wedge-shaped or parabolic front ends, but summing up these tests, the following statement is made: As the air resistance forms the greater part of the total resistance of rapidly moving trains, it is essential to design the outer form of the car so that the air resistance should be reduced as much as possible. According to the results of the tests described above, the best conditions would prevail if the front end of the car had the form of a very sharp parabolic wedge.

Air Resistance.

(Taken from the Report of the Electric Railway Test Commission, Louisiana Purchase Exposition, 1904.)

In the car used with flat ends, the maximum speed obtained was 50 miles per hour; with parabolic ends, maximum speed was increased to 75 miles an hour.

The head-on pressure for all speeds averaged about one-fourth for parabolic front of what it did for a square front.

Unit pressure at 80 miles per hour was ten times that at 20 miles per hour.

At 60 miles per hour the unit pressure on a wedge-shaped front was 2.1 pounds and on a flat vestibule 8.2 pounds.

On a flat vestibule, the unit pressure at 20 miles per hour was 1.4 pound; at 80 miles per hour it was 14 pounds; on a wedge-shaped end 0.4 of a pound at 20 miles per hour, and 4 pounds at 80 miles per hour.

The suction at the rear end on the standard vestibule was equivalent to 16 horsepower at 60 miles per hour.

Transmission.

The gasoline engine is unquestionably a successful, practical and economical power generator; the motor-car body, trucks, etc., built of steel, have been perfected. The means for connecting the gasoline engine to a motor car is the main difficulty in utilizing the power of an internal-combustion engine. A variable speed engine, adapted for controlling the car at various speeds, and a mechanical means for throwing in a gear for starting the car, to be used in case of emergency on excessive grades, is so simple that it leaves no doubt as to the practicability of this form of construction. With the Union Pacific motor cars†, after the car is once in motion, the propelling mechanism consists simply of an engine and a sprocket mounted on crank-shaft, the power being transmitted therefrom through a chain, into a second sprocket keyed on the driving axle. There are no noisy gears, no complicated mechanism for the absorption of the power; it is so simple that the economical and practical features of this transmission can be readily appreciated.

The Engine.

It is generally conceded that a gasoline engine is a constant-speed machine; that used as a power generator, any variation in speed must be secured by mechanical methods outside the gasoline engine. The gasoline engines used for stationary purposes are all regulated by a governor and maintained at a constant speed. In the automobile business it is particularly noticeable that foreigners, in building their machines, figure on controlling the speed of the automobile by a multiplicity of gear speeds, often as high as four or five gear speeds, thus by their design admitting the gasoline engine should run at a certain fixed speed. American builders of automobiles frequently control their machines with only two gear speeds, although many of them use as high as four and five. All motor-car experiments up to date have been based on the constant speed of a gasoline engine.

One of the most attractive features of the steam automobile is the ease with which the speed of the machine is controlled. This is due to the flexibility in control of the steam engine. We see on the locomotive every day the flexibility of the steam engine utilized in starting passenger and freight trains from a condition of rest, accelerating them to a speed of 70 to 80 miles an hour. Now, for a motor car to operate on a steam railroad where the simplicity of the machine is almost imperative, and all conditions such that an operator with a reasonable amount of experience may direct his mind to guiding the car from station to station, at the same time being able to keep his eye continually on the track—the gasoline engine and machinery for propelling the car must be flexible of control and of itself require very little attention; in other words, it must be analogous to a steam locomotive—able to stand hard service, hard work and abuse, and yet at

† For previous articles on the Union Pacific Motor Cars see RAILWAY MACHINERY, March, 1906, and May, 1906.

the same time be sure, be reliable in its performance, and avoid stoppages between stations where these would cause undue complications in the operation of regular train service.

Union Pacific motor cars were originally designed and developed on the basis of controlling the speed of the car by varying the speed of the engine; accelerating the speed by opening the throttle, thus giving the engine more gasoline, this being analogous to opening the throttle on a locomotive; advancing or retarding the spark being analogous to varying, by the reverse lever, the valve motion and the lead of the valve on the locomotive.

Motor car No. 8 was equipped with a 200-horsepower gasoline engine, designed and built at the Union Pacific shops, at Omaha. The engine was designed particularly for motor-car service, and the hope for a flexible-control engine has been fully realized, the engine being able to start and accelerate the car from zero to 60 miles an hour simply by varying the speed of the engine. If the car attains a speed of 50 miles, and it is desired to run slower, the same can be accomplished by simply closing off the throttle, reducing the consumption of the gasoline, and thereby saving fuel. Thus you control the horsepower developed in the engine by means of the gasoline supply, and the cost of fuel, then, must be in proportion to the power demanded from the engine. In my opinion, this saving in a gasoline engine is proportionately greater than in a steam locomotive. This flexible control of the gasoline engine is obtained through the following: (1) Utilization of six cylinders, giving a power impulse to the shaft three times each revolution; (2) by balancing the crank-shaft and reciprocating parts (the uniformity of speed is improved); (3) the gasoline vapor pipes from carbureter to cylinders are, by special design, all equally divided, and the distance the vapor travels is the same in each and every case; thus no one cylinder takes its charge of gasoline at the expense of another; (4) the dimensions of the cylinders, the opening and closing of the inlet and exhaust valves and the relative timing of these valves to each other, as well as to piston, have all been of particular importance; (5) (as before mentioned) the valve motion of a six-cylinder gasoline engine is analogous in many ways to the valve motion of a steam locomotive. We know perfectly well that a valve motion suitable for a high-speed passenger train is not economical, nor is it satisfactory for hauling heavy freight trains. The idea in the valve motion of the motor-car gasoline engine is to operate the valves so as to produce as nearly as possible uniform horsepower by these cylinders at various speeds.

In moving the car through a series of switches in a busy yard, with the necessity for letting the brakeman off to run ahead and throw switches, picking him up after passing through same, it is almost imperative that the operator be not bothered or interfered with by the necessity of throwing speed-changing devices, etc. With the Union Pacific variable-speed engine the operation is very simple, the throwing on or off of the friction clutch being the only move necessary to vary the speed of the car. Even though the car reduces to a speed of two or three miles an hour by simply throwing in the clutch, the load will be assumed and taken care of by the engine without any bucking, such as is often experienced with automobiles and other constant-speed engines. The throwing on or off of the clutch is actuated by air; the air, being controlled by an operating valve, the lever of which, being small and in the hands of the operator, makes it easy for him to keep his head out of the window, watch the brakeman, the movements of the car, and handle the gasoline-engine mechanism without any undue complications or without taking his eye off the track.

Cost per Mile for Operation of Motor Cars, including Cleaning, Running and Shop Repairs, Fuel, Lubricating Oil, and Wages of Motormen and Conductors.

The expense of fuel, repairs, cleaning, etc., runs very uniformly, but with the expense per mile being so largely dependent upon the number of miles run per day, as well as on the wages paid the car crew, comparisons are very unsatisfactory. In actual service cars run, some months, as low as 10 and 11 cents a mile; whereas, cars in other localities will run as high as 16 and 18 cents a mile, and in one case, where a 100-horsepower motor car and trailer has replaced a steam locomotive and train, on account of the limited mileage made per day, the cost of operation runs as high as 20 cents a mile. On branch lines the motor car should make not less than 100 miles a day. The service of the gasoline motor car is unquestionably different to that of either electric or steam cars. To man the gasoline car with a steam train crew is exceedingly expensive and inadvisable, and does not produce proper results; to man the gasoline motor car with an electric car crew would be equally as unsatisfactory. A well-paid mechanical man to have entire charge and run the motor car, with an assistant to collect tickets, is the best and most economical arrangement possible.

* * *

WESTBROOK CRANK-PIN TURNING MACHINE.

The accompanying Figs. 1 and 2 show a new portable locomotive crank-pin turning machine designed by Mr. M. H. Westbrook, Port Huron, Mich., which is of interesting and meritorious construction. It is so made that modern type crank-pins used with solid end rods may be turned with the wheels under the locomotive, if need be, and brought back to their original centers, no matter how badly worn. The centering of the machine and lining up with the original axis

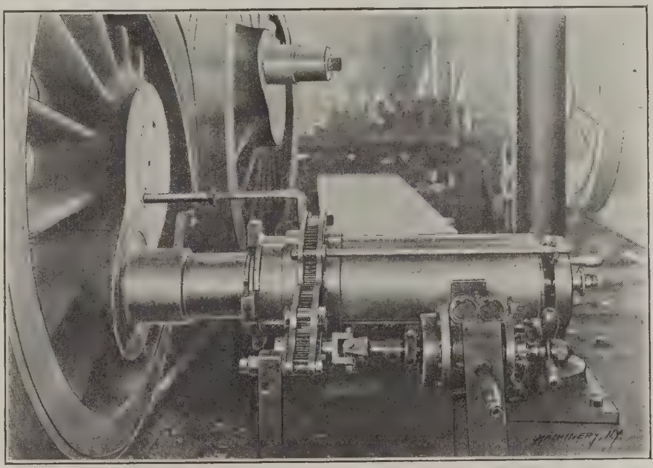


Fig. 1. Westbrook Crank-pin Turning Machine, ready for Operation.

of a worn pin is accomplished without effort on the part of the operator, the whole support being the so-called "gudgeon" screw, which carries the collar and retaining nuts, and the faced end of the pin. Inasmuch as these parts are truly turned and faced in an engine lathe while on centers, and are not subject to wear, it follows that they may be safely relied on to re-center the machine for correcting the contour of a worn pin. It was on this principle that the Westbrook machine was designed, the supporting part being chucked by screwing onto the gudgeon screw until it comes up solidly against the faced end of the pin.

Fig. 1 shows the machine in place ready for turning, and Fig. 2 shows the parts. The piece *A* directly under the crank-pin is the part that is screwed on the gudgeon screw *E*, two handles, which are afterward removed, being provided for the purpose. Then the sliding sleeve *B* at the left is placed on the mandrel. This sleeve has four lugs or tool-holders to carry the necessary tools for roughing, finishing and filleting. The tools are made of ⅝-inch round high-speed steel. The gear-driving train *C*, shown at the right, is slipped on the sleeve over two feather keys by means of which motion is imparted to the sleeve. An air motor couples directly to the taper shank, shown projecting from the front of the gear case. The feeding motion of the sleeve is accomplished by a mechanism *D* contained in the hand-wheel, and the feed may be either automatic or by hand according as the gearing is engaged or disengaged. It is not necessary to stop the motor to change from hand to power feeding. Provision has been made for any lost motion accruing from ordinary wear and tear of the mandrel and sleeve, adjustable rings having been provided which are screwed against taper split bushings on each end.

While the four parts into which the machine is separated are none of them too heavy to be handled by even a boy, the machine is of ample capacity and will restore the largest locomotive crank-pin to its original shape in three hours. Thus a great saving of time is effected as compared with the practice of removing the crank-pin or filing it up by hand, and of course the ease and simplicity of setting the machine saves time over other machines which are set by calipering.

The machine can be adjusted to any pin having a threaded end by simply making a face-plate to suit, threading it to fit the pin and the extension mandrel. It may be used in the roundhouse without removing the wheels from the engine, and is successfully operated with 70 pounds air pressure, using a "Little Giant" air motor.

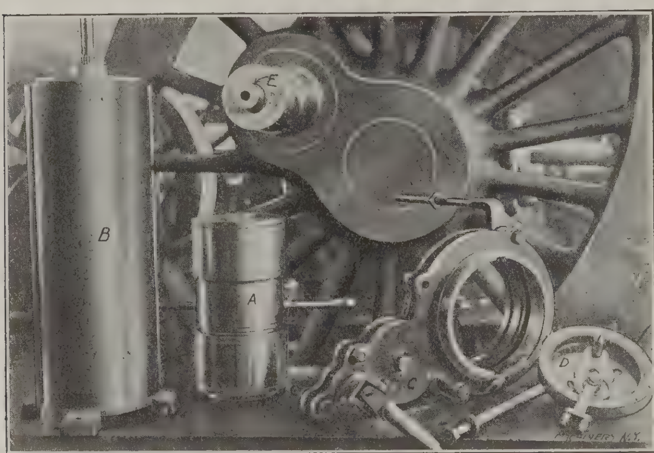


Fig. 2. Details of Crank-pin Turning Machine.

Mr. Westbrook informs us that as a result of several years of observation it has been demonstrated that, provided the main pins are maintained in a true condition, those in the front and rear wheels require little or no attention. However, that may be, we all know that the number of rod breakages and the general wear and tear will be materially lessened when all crank-pins are kept true and to their original center distance. Several of these machines are now in use by the Grand Trunk Railway.

* * *

GERMAN FIRELESS LOCOMOTIVES.

In describing the locomotives at the exposition in Milan last summer, the *Zeitschrift des Osterreichischen Ingenieur- und Architekten-Vereines* shows a photograph and gives a description of the fireless 2—2—0 locomotives built by A. Borsig in Berlin-Tegel, Germany. This firm builds fireless locomotives in seven different sizes, varying from 7 to 31 tons. These locomotives are used mostly inside of large factories and in mining work, and are used particularly with the object of avoiding smoke and danger of causing conflagrations. The locomotives are charged with steam from a stationary boiler, the charging taking a time of from 20 to 30 minutes. The boiler is constructed so as to prevent as much as possible heat losses by radiation. When the boiler is filled, the locomotive is able to run for about six hours. It is understood that locomotives for this kind of service are not constantly in motion. The cylinders are of such a size that the locomotives can return to the stationary boiler for new charging of steam if the gage pressure is only from 5 to 7 pounds. The engines use about 53 pounds of steam per horsepower hour. The locomotive exhibited was one of 28 horsepower. The main dimensions are:

Size of cylinders	16½ x 15¾ inches.
Diameter of driving wheel	35½ inches.
Wheel base	5 feet, 7 inches.
Volume of boiler or receiver	159 cubic feet.
Maximum steam pressure	180 pounds.
Weight, empty	13.7 tons.
Weight in use	17.6 tons.

* * *

The number of automobiles registered in the United States has reached a total of 140,000 machines, according to figures compiled by the Auto Directories Co. of New York.

BUFFALO, ROCHESTER & PITTSBURG R. R. DECAPOD LOCOMOTIVES.

Six decapod (2—10—0) engines are now under construction at the Brooks Works of the American Locomotive Company for the Buffalo, Rochester & Pittsburg Railroad. The engines are intended for pushing service and are the heaviest simple engines ever built by this company. It is estimated that they will have a total weight in working order of 275,000 pounds, of which 248,000 is carried on the driving wheels. The maximum tractive power is 55,350 pounds which gives a factor of adhesion of 4.5.

The cylinders are 24 inches in diameter by 28 inches in stroke and are equipped with slide valves operated by the Walschaerts valve gear. As the valves are outside admission, the connection of the radius bar to the combination lever is below the valve stem. The link is supported by a special shaped casting secured to the back of the guide-yoke, and the reverse shaft is carried in bearings bolted to the top of a cast steel cross-tie located between the second and third pair of driving wheels. This permits of the direct connection of the reverse-shaft arm with the radius-bar. Reference to the illustration of the side elevation of the engine will show the advantage taken of the opportunity afforded by the use of the Walschaerts valve gear for the introduction of strong bracing between the frames and the frames and boiler.

One of the interesting features of this design is the use of a combustion chamber in the boiler. The results in the way of a reduction in boiler troubles obtained by the use of the combustion chamber on the Northern Pacific have been most satisfactory, and the introduction of the combustion chamber in these engines shows evidence of an increasing belief among railroad men in its advantages for wide firebox engines burning soft coal. The advantages claimed for the combustion chamber are that it removes the tubes from the hottest part of the fire, thereby decreasing flue leakage; adds to the heating surface of the firebox; and gives a largely increased firebox volume which tends toward better combustion. In these engines the combustion chamber is 3 feet long and is stayed to the shell of the boiler by radial and sling stays on the upper section and by radial stays on the sides and bottom, bracing rods being also attached to the bottom and extending forward to the waist to add stiffness. Ample clearance between the combustion chamber and the shell of the boiler is provided to furnish good water circulation.

The boiler is of the wagon-top type, 80 inches in diameter at the front end, and has a total heating surface of 3,535.5 square feet, of which the tubes contribute 3,280 square feet and the firebox the remainder. The tubes are 2 inches in diameter and 15 feet 6 1/16 inches long, there being 404 in the barrel of the boiler. The introduction of the combustion chamber, of course, reduces the amount of tube heating surface, but experience on the Northern Pacific Railway has proved that the increase in firebox heating surface more than offsets this loss, and that engines with combustion chamber and less actual heating surface steam fully as well as those without combustion chamber and more heating surface.

The firebox is 108 inches long and 73¼ inches wide, which gives a grate area of 55.5 square feet. The frames are of cast steel with double front rails and are 6 inches wide.

Another distinguishing feature of these engines is the unusually large capacity of the tender. The tank is of the water-bottom type and has a capacity of 9,000 gallons, which, to the best of our knowledge, is the largest water capacity ever provided in a locomotive tender.

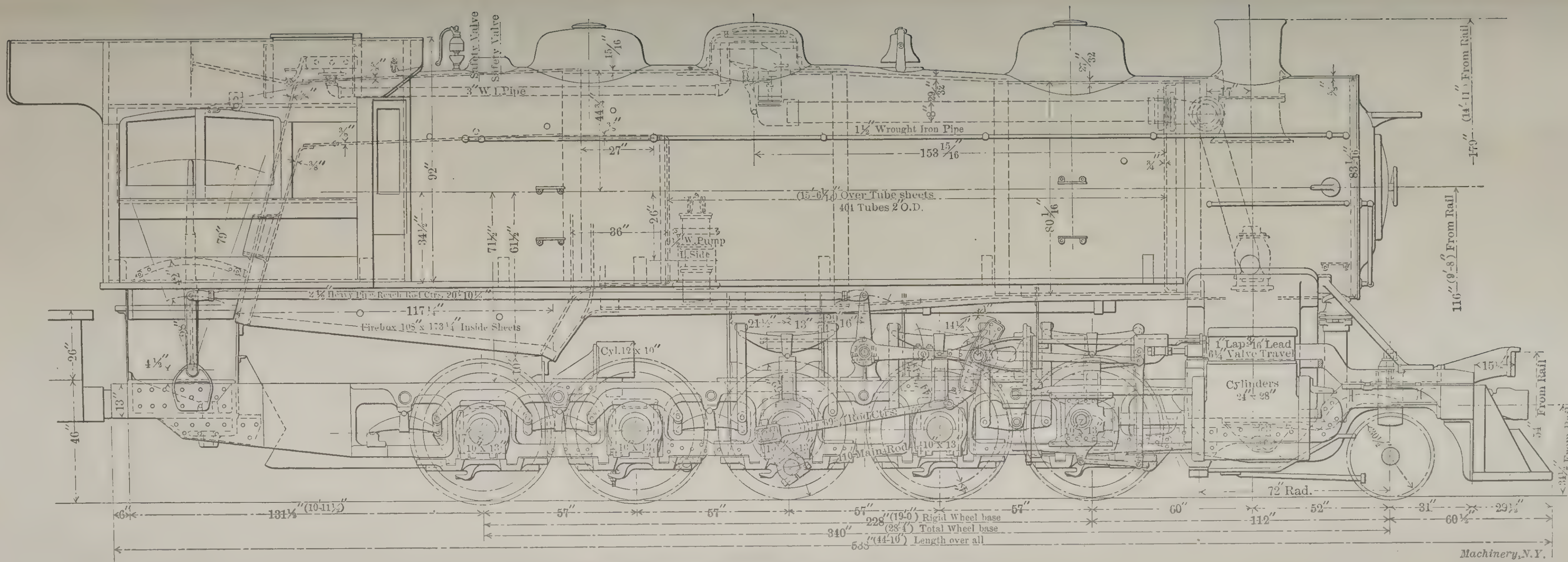
Some of the principal ratios of the design are as follows:

$$\frac{\text{Weight on drivers}}{\text{Total weight}} \ldots\ldots = 0.9$$

$$\frac{\text{Weight on drivers}}{\text{Tractive effort}} \ldots\ldots = 4.5$$

$$\frac{\text{Tractive effort} \times \text{dia. drivers}}{\text{Total heating surface}} \ldots\ldots = 815$$

$$\frac{\text{Tube heating surface}}{\sqrt{\text{Length of tubes in feet}}} + \text{Firebox H.S. (equated H.S.)} = 1088$$



Buffalo, Rochester & Pittsburg Railroad Decapod Locomotive.

$$\frac{\text{Total heating surface}}{\text{Grate area}} = 63.6$$

$$\frac{\text{Weight on drivers}}{\text{Total heating surface}} = 70.3$$

Volume of both cylinders (cubic feet) = 14.62

$$\frac{\text{Total heating surface}}{\text{Volume of cylinders}} = 241.5$$

$$\frac{\text{Grate area}}{\text{Volume of cylinders}} = 3.8$$

In comparing these engines with others of a similar type it must be remembered that the introduction of the combustion chamber reduces the actual amount of heating surface and thereby affects those ratios in which this dimension appears. Following are the principal dimensions and weights:

Cylinder, type, simple slide valve; diameter, 24 inches; stroke, 28 inches; piston rod diameter, 4½ inches; piston packing, snap rings. Valves, type, Richardson; travel, 6¼ inches; steam lap, 1 inch; lead, 3/16 inch.

Gage, 4 feet 8½ inches; wheel base, driving, 19 feet; rigid, 9 feet; total, 28 feet 4 inches; total, engine and tender, 65 feet 3½ inches.

Weight in working order (estimated), 275,000 pounds; on drivers, 248,000; engine and tender, 437,000 pounds; tractive power, 55,350 pounds.

Axles, driving journals, main, 10½ x 13 inches; others, 10 x 13 inches; engine truck journals, diameter, 6½ inches; length, 12 inches; tender, truck journals, diameter, 5½ inches; length, 10 inches.

Boxes, driving, main, cast steel; others, cast steel.

Boiler, outside diameter, first ring 80 inches; working pressure, 210 pounds; fuel, soft coal.

Heating surface, tubes, 3,280 square feet; firebox, 255.5 square feet; total, 3,535.5 square feet.

Firebox, type, wide; length, 108 inches; width, 73¼ inches.

Grate area, 55.5 square feet; style grate, rocking.

Thickness of crown, ⅜ inch; tube, ⅝ inch; sides, ⅜ inch; back, ⅜ inch.

Water space, front, 4½ inches; sides, 4½ inches; back, 4½ inches.

Crown staying, radial, 1 inch diameter.

Tubes, material, charcoal iron; number, 404; diameter, 2 inches outside; length, 15 feet 6 1/16 inches; gage, No. 11.

Exhaust pipe, single.

Smokestack, diameter, 20 inches; top above rail, 14 feet 11 inches.

Brake, driver, Westinghouse-American; tender, Westinghouse; pump, 9½ inch; reservoir, 22½ x 140 inches.

Tender, frame, 13-inch channel; tank, style, water-bottom; capacity, 9,000 gallons; fuel capacity, 14 tons.

Wheels, driving diameter, outside tire, 52 inches; center diameter, 44 inches; material, main, cast steel; others, cast steel; engine truck, diameter, 30½ inches; kind, Boise steel-tired; tender truck diameter, 33 inches; kind, cast iron plate.

Engine truck, radial swing, three-point suspension.

* * *

The plans for the enormous electric water power station which will utilize the water power of Trollhättan in Sweden for supplying power mainly for the state railways, are now completed. According to the estimates a station providing for the generation of 76,000 horsepower will cost about $3,000,000. The work is supposed to be completed in the fall, 1909. The Trollhättan water falls, the power of which is already used to a great degree for private enterprises, are the largest water falls in Europe in regard to volume of water and the power possible to be derived from their utilization. The electrification of the state railroads in Sweden seems to be fairly well assured at the present time, inasmuch as the government has acquired several of the largest sources of water power in the country capable of generating in all 500,000 horsepower.

ELECTRIC RAILWAY MACHINERY AND APPARATUS.—3.

WM. BAXTER, JR.

In the last article it was shown that electric currents flowing in wires parallel with each other will exert an attractive force, if the currents flow in the same direction, and a repulsion if they flow in opposite directions. We also explained that the two effects were caused by the magnetic envelope that surrounds the current. This fact can be further demonstrated by the action of permanent magnets upon each other. Permanent magnets are made of steel that is well hardened, and after being hardened is magnetized by

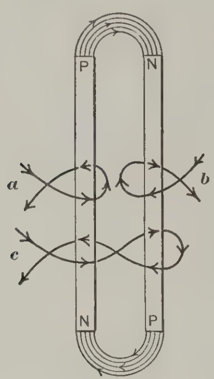


Fig. 12.

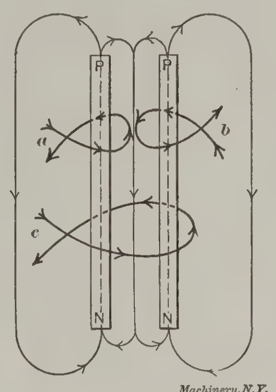


Fig. 13.

being placed within a coil of wire through which an electric current is passed. As we have shown, a bar of soft iron will become magnetized when used as the core of a wire coil, but it will not remain magnetized; on the contrary, it will lose its magnetism the instant the current stops flowing through the wire. This property of soft iron, which might appear as an objection, is in reality a decidedly valuable feature, because it is what renders it possible to make electric motors and generators that are practical machines. The property of retaining magnetism, possessed by hardened steel, is also valuable in other directions, principally in the operation of electrical instruments and small apparatus where certain actions are required that could not easily be obtained by other means. The two illustrations, Figs. 12 and 13, serve to show how the repulsive and attractive effects of electric currents can be duplicated by permanent magnets, thus giving a further proof of the fact that these effects are due wholly to the magnetic envelope that surrounds the current.

The Action of Permanent Magnets.

In Fig. 12 the two bars *P N* represent permanent magnets placed side by side, with the positive pole of one at the upper end, and the positive pole of the other one at the lower end. When the bars are so placed, if they are held so as to move freely, they will be drawn toward each other. This action, it will be seen, is strictly in accordance with the property of contraction of magnetic lines of force that we have already explained. This much is made clear by the fact that the lines of force of one magnet will flow through the other magnet, thus making a closed magnet circuit of the two magnets.

At a first glance it might be thought that this action of the two permanent magnets, while it shows the property of attraction, does not fully demonstrate that the attraction of two wires carrying currents is due to the magnetic envelope that surrounds them; because in the case of the currents they must flow in the same direction to attract each other, while the magnets must be set with their positive ends pointing in opposite directions. If, however, the wire loops *a* and *b* are examined, it will be seen that the arrow heads on these indicate the direction in which electric currents would have to circulate around the magnets to magnetize these with their positive ends, or poles, in the direction in which they are shown. It will further be seen that where these loops pass side by side, between the two magnets, the currents in them flow in the same direction; hence, the currents will attract each other. It can further be seen that if we make a single coil to carry the current around both magnets so that it may flow in the right direction, it will have to be crossed at the center, as indicated in *c*.

Like Poles Repel—Opposite Poles Attract.

In Fig. 13 the two magnets are placed with the positive poles at the upper end and in this case there is a repulsive action, which is due to the fact that the lines of force of one magnet cannot pass through the other, as the two magnetic fluxes flow in opposite directions; hence, they must pass down between the two bars, thus producing a repulsive effect. In this case if we look at coils *a* and *b*, which show the direction the electric currents should flow to develop positive poles at the upper end of both magnets, we will find that in the center space they will flow in opposite directions, so that the currents will repel each other.

If Figs. 12 and 13 are modified in the manner shown in Figs. 14 and 15, so that the two magnets are mounted upon a central stud, and are free to swing around this point, then we will find that if the positive pole of one is opposite the negative pole of the other, there will be an attraction, and if the vertical bar is held stationary the other one will swing around until it comes in line with it, and will be held in that position unless a considerable force is used to move it away. If the two magnets are placed as in Fig. 15, the like poles opposite, they will push away from each other, and the inclined one will swing around counter-clockwise until its lower end reaches the top position, back of the *P* end of the stationary magnet.

Permanent Magnets Not a Source of Power.

Many men not well informed on the elementary principles of physics have thought that it might be possible to juggle in some way with this attractive and repulsive property of permanent magnets so as to produce a perpetual motion machine, but such a result is impossible for the simple reason that it requires just as much effort to draw the magnets apart, after they have come together, as they develop in the act of drawing together. There is but one way in which this attraction and repulsion of magnets can be made available for the production of power, and that is by causing the magnetic force to disappear after the magnets have been drawn together by their attractive force, or pushed apart by their repulsive force. This result can be accomplished by making one of the magnets in the form of an electromagnet, so that its magnetism may be destroyed after it has moved into a position parallel with the other magnet. To illustrate this point, suppose that in Fig. 15 *a* is a permanent magnet and *b* is an electromagnet. If *a* is held stationary, *b* will rotate counter-clockwise until its *N* end reaches the top position, and if at this instant the current is cut off, the magnetism of *b* will disappear, and its momentum will carry it forward,

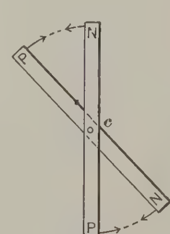


Fig. 14.

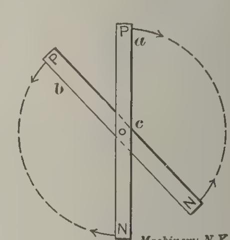


Fig. 15.

beyond the position of *a*. If immediately after the current is cut off it is turned on again, but flowing in the opposite direction, then the upper end of *b* will be changed from negative (*N*) to positive (*P*) and once more the repulsive action of the two upper ends of the magnets, and the attraction of the upper end of *a* for the lower end of *b* will be set up; and as a result the magnet *b* will be rotated through another half revolution. Thus it will be seen that if at each half revolution we stop off the current flowing through the coil of the electromagnet *b* and immediately send through it another current flowing in the opposite direction, we can obtain a continuous rotation. This, however, makes it necessary to use an electric current to develop the magnetism in the movable magnet *b*, and as it requires power to generate electric currents we do not obtain a perpetual motion device.

but on the contrary an entirely rational machine that simply transforms the energy of the electric current into mechanical energy, or power. This simple device is an electric motor in its simplest form, but in it the principle of operation is the same as in the most elaborate motors made. In the early part of the last century, when little was known about electricity, motors of small size were made in the manner just described, that is, a permanent magnet for one of the parts, and an electromagnet for the other. At the present time both parts are made of electromagnets, because the latter can be made to develop a vastly greater attractive force, for a given size, so that by their use motors can be constructed that will develop many times as much power (from 10 to 100 times as much) for the same size machine.

Fundamental Principle of Electric Motors.

The fundamental principle of action of modern electric motors can be made clear by the aid of Figs. 16 and 17. In the first named figure, *F* represents the stationary part of the

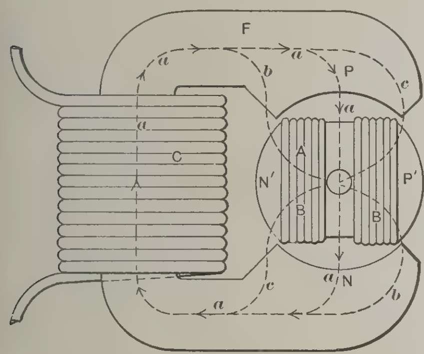


Fig. 16.

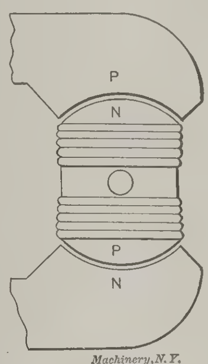


Fig. 17.

motor, which is called the field-magnet, or simply the field. It is in the great majority of cases a casting, either of soft iron or mild steel. The part *A* is the revolving member and is called the armature. It is built up of many thicknesses of thin sheet iron or special steel, known in the market as electric steel. The laminations are at right angles to the shaft, and are held together by means of bolts, rivets or some kind of clamping device that presses them together in a direction parallel with the shaft. The armature is covered with wire coils, which in Fig. 16 are represented by *B B*, and when an electric current passes through these the iron part, which is called the armature core, is magnetized. The direction of the field magnetism, in Fig. 16, would be as indicated by *P* and *N*, but the means employed to convey the current to the coils *B* are such that the polarity of the armature is reversed at each half-revolution, that is, the right side, which is marked *P′* remains such until one-half of a revolution is made, when it is reversed and becomes *N′*. The field is magnetized by the coil *C*, and an electric current flows through this in the same direction all the time the motor is running, thus keeping the polarity of the field unchanged. If current passes through coil *C* only, there being no current traversing coils *B B*, the path of the magnetic flux developed by coil *C* will be along the line marked *a*. If now a current is also passed through coils *B*, and in such a direction as to give the armature the polarity indicated by *P′* and *N′*, then the *P* pole of the field will pull on the *N′* pole of the armature, while the *N* field pole will pull on the *P′* armature pole, and this fact we can illustrate by assuming that the presence of the lines of force induced by the armature coils *B* has shifted the field magnetic flux from the path *a* to that indicated by *b*. In this way a rotative force is developed that will swing the armature around until it reaches the position of Fig. 17. To cause the armature to rotate further than the position of Fig. 17 it is necessary that when this position is reached, the current through the *B* coils be reversed, so as to reverse the polarity of the armature; that is, so as to make the top armature pole *P′* and the bottom one *N′*. As soon as this change in polarity is effected, by the reversal of the electric current, the top field pole will push the top armature pole away while this same pole will be attracted by the lower field pole, and thus a rotative force will be exerted that will carry the armature through another half-revolution. By changing the direction of the current through the *B B* coils at each half-revolution, the rotation can be made continuous. The apparatus by means of which the reversal of the current through the armature coils is effected is called a commutator.

In actual motors, the two simple-looking coils *B* of the armature are replaced by a large number of coils that are wound so as to cover the whole of the armature surface, and this fact may lead to the conclusion that in such machines the principle of operation is entirely different from that illustrated in Figs. 16 and 17, but such is not the case, as we will clearly demonstrate hereafter. If with the armature in the position of Fig. 16, the current is passed through coils *B* in such a direction as to develop a *P′* pole at the right, and the *N′* pole at the left, the armature will be pulled around in a clockwise direction, through the effort of the displaced magnetic flux to return from the path *b* to the central position *a*. If when the armature is in this position the current is passed through the *B* coils in the opposite direction, so as to develop the *P′* pole on the left, and *N′* on the right, then the magnetic flux can be regarded as displaced to the position of line *c*, and to return to the central position it must swing the armature counter-clockwise. Thus it will be seen that to cause the motor to run in the opposite direction all that is necessary is to reverse the direction of the current through the armature coils. The reverse of the current at each half-revolution, that is required to keep up a continuous rotation, is effected by means of the device called a commutator, already referred to. This is a part of the machine. For the purpose of reversing the current when it is desired to reverse the direction of rotation of the armature, a reversing switch is used, and this is not a part of the machine, it is an independent device which is not necessary for the proper operation of the motor, and is not required if the motor is to run in the same direction all the time. The general principle of action of commutators will be fully explained hereafter, but before taking up that subject we will explain the fundamental principles of electric generators.

Inductive Effect of a Conductor.

In Fig. 18 the central shaded circle *A* represents a section of wire. From what we have already explained, if there is a current flowing through this wire it will be surrounded by a magnetic flux that we represent by the circular

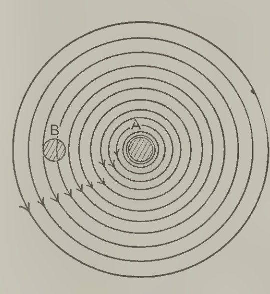


Fig. 18.

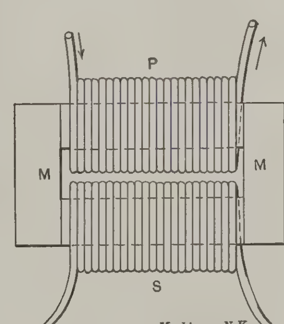


Fig. 19.

lines of force shown. When there is no current flowing through the wire there is no magnetic flux, hence, when the current starts to flow the flux must begin to swell out from the wire, the circular lines of force being considered as continually expanding as long as the current is increasing in strength. When the current reaches its full strength the circular lines of force will stop expanding and remain stationary until the current begins to die out, then as the current gradually reduces, the circular lines of force will gradually contract upon the wire, and when the current is reduced to nothing, all the lines of force will have contracted to the center of the wire and have disappeared. In this operation of expanding, while the current was growing from zero to its full strength, and of contracting, while the current was reducing from its full strength to zero, the circular lines of force would cut through a wire placed at *B*, and in so doing would generate an electric current in this wire if it formed a closed electric circuit. The direction of the current induced

in wire *B* depends upon the direction in which the lines of force cut through it, and as the direction when the lines are swelling out from *A* is the reverse from what it is when they are contracting upon *A*, it follows that while the current in *A* is increasing, the current induced in *B* will be in the opposite direction from the current induced while the current in *A* is decreasing.

The Primitive Electric Generator.

From the foregoing it will be seen that to induce an electric current in a closed electric circuit all that is necessary is to cause a magnetic flux to sweep across some portion of that circuit. In the arrangement of Fig. 18 if the current passing through wire *A* is what is called a direct current, that is, one that flows all the time in the same direction, then there would be no current induced in *B* except during the very short interval while the current is increasing at the instant of starting, or decreasing at the time of stopping, but during all the time the current is flowing through *A* without changing its strength, there will be no current induced in *B*. If the current passing through *A* is what is known as a pulsating current, that is, one that is continually increasing and decreasing in strength, or better still, if it is an alternating current, that is, a current that flows first in one direction and then in the reverse direction, then the current induced in *B* will flow all the time, but it will be an alternating current, because it will be made up of a succession of inductive effects produced by the magnetic flux, first sweeping over the wire while expanding away from *A*, and then sweeping over it again while contracting upon *A*, moving in opposite directions alternately. The principle above explained, which is called electro-magnetic induction, is used in connection with

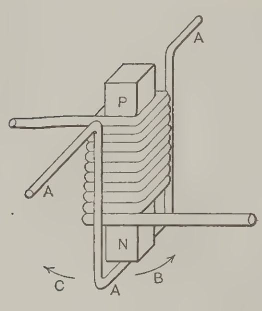


Fig. 20.

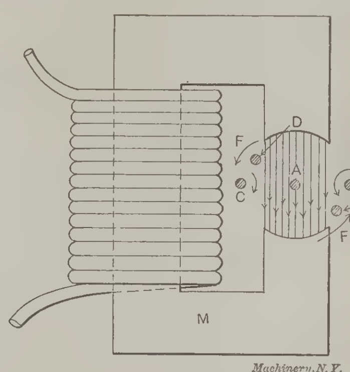


Fig. 21.

alternating electric currents to enable one current to induce another current in a separate circuit. The apparatus used for this purpose is called a transformer, and is represented in a simple form in Fig. 19. It consists of two wire coils, *P* and *S*, placed upon an iron core *MM*. The only object of the core is to intensify the action of the apparatus and utilize the inductive action of the first current, which is called the primary and passes through coil *P*, to its fullest extent. The current induced in coil *S* is called the secondary current, and if the apparatus is well proportioned and designed, it is very nearly equal in energy value to the energy absorbed in the primary current. The principles, construction and object of transformers will be more fully explained in a future article.

Since to induce an electric current in a closed electric circuit, all that is necessary is to cause a magnetic flux to sweep over some portion of the circuit, it follows that if the magnetic flux is stationary, as is the case when it is induced by a continuously flowing direct current, all we have to do to obtain the inductive effect is to move the electric circuit mechanically across the magnetic flux. A simple way of doing this is shown in Fig. 20, in which *P N* represents the core of an electromagnet kept magnetized by a direct current flowing through the wire coil wound around it, and *A* represents a portion of a wire electric circuit, that is arranged to swing back and forth, as indicated by the arrows *B C* across the flux issuing from the lower end *N* of the magnet. From what has been said in the foregoing it can be understood that each time *A* swings across the face of the magnet pole a current will be induced in it, the current being in one direction for a swing from right to left, and in the opposite direction for a swing from left to right. This simple arrangement acts upon the same principle as the largest electric generators made, and if the wire *A* were kept swinging back and forth continuously, it would be a perfect alternating current generator, although not a very efficient one.

A Generator is a Reversed Motor, and Vice Versa.

Looking now at Fig. 21, let us suppose that the coil on *M* is traversed by a direct current that will develop a magnetic flux passing from the upper down to the lower pole, as indicated by arrow heads on the lines of force. Let *A* represent a wire that is free to move to either side, and suppose that a current is passed through it. Now remembering what we said about the repulsion of magnetic fluxes flowing in the same direction, it can be seen that if the current through *A* develops a flux that is directed clockwise, the wire will be thrust aside to the left, to the position *C*, and if the current through *A* is in the reverse direction, so as to develop a counter-clockwise flux, the wire will be forced to the right, to position *B*.

Let us now suppose that *A* represents a shaft, and that *E* and *D* represent the sides of a wire loop that is fastened to *A* so that it may rotate with the shaft, then if a current is passed through the loop in a direction to develop a flux directed as indicated by the arrows around *B* and *C*, rotation will be produced in a counter-clockwise direction until the sides of the loop reach the position of *B* and *C*. If the direction of the current passing through the loop is reversed, the rotation will be in a clockwise direction until side *D* reaches the position *B*. In all these experiments we have assumed that a current of electricity is passed through the wire, and we have found that in every case a force is developed that causes the wire to move out of the magnetic flux of magnet *M* to one side or the other, according to the direction of the current through the wire. Hence these several arrangements constitute simple forms of electric motors, as they are arrangements by means of which the energy of the electric current flowing in the wire is made to impart motion to the latter. By changing the experiments slightly we can show that these same arrangements of the wire can also act as electric generators. To accomplish this all that is necessary is to move the wire through the magnetic flux without passing a current through it, and then if the wire is a part of a closed circuit, an electric current will be induced in it in precisely the same way as in Fig. 20. If the wire is not a part of a closed circuit, an electrical pressure, electromotive force, will be developed, but there will be no current because there is no path for a current to flow in. Thus it will be seen that the movement of a conductor across the magnetic flux causes an electromotive force to be developed, and that if there is a closed circuit connecting the two ends of the conductor, an electric current will flow therein. If the ends of the conductor are disconnected, so that no current can flow, no effort will be required to move the conductor across the magnetic flux, but if the ends are connected so that a current can flow, the movement of the conductor will be resisted, thus showing that to generate a current power must be applied.

* * *

A new railway project is under way in Switzerland which will range among the most costly and difficult railway undertakings in the world. As stated by the *Times Engineering Supplement*, this line will be from Zinel to Zermatt, and will be about 15½ miles long. In this distance it rises 3,412 feet, and descends on the other side of the mountain range 3,445 feet. The maximum gradient will be 1 in 5; the line will be worked electrically and is a rack and pinion railway wherever the gradient exceeds 8 per cent. The estimated cost for this undertaking is $1,600,000 or slightly more than $100,000 per mile, which, considering that the railway is only a single-track road, 3 feet 3⅜ inches gage, is an enormous construction cost.

* * *

The bald or flangeless driving tire for locomotives was patented in the United States 1833. The object of the "invention" was to relieve the cranked axles of inside connected locomotives of the bending stresses imposed by the pressure of the rail on the flanges when rounding a curve.

A SHOP WITH A HISTORY.*

THE PUTNAM SHOP IN FITCHBURG.

H. P. FAIRFIELD.

A history of the beginning and development of the Putnam Machine Co. of Fitchburg, Mass., is so nearly a history of many of the older New England machine industries that it must have a genuine interest to all shop men and shop engineers.

The firm is an interesting one from the fact that since its formation, in 1835-36, it has been the Putnam Machine Co. in deed and name, and is now owned and managed by Putnams who are of the original stock.

To one interested in economic questions, the firm also has much to render it interesting regarding its methods of treating its employes. As one goes through the works, the number of elderly men at work impresses the visitor as unusual in these days of squeezing out of old men in favor of the younger members of the fraternity. At the Putnam Company the old employes *die out* instead of being forced out; nor are they degraded by having their pay reduced; neither are they made helpers or sweepers, but instead are allowed to continue as equals of the other members of the working force, and at the same line of work in which they have been serving the firm in their more valuable years.

The writer, in conversation with George Boss (a workman), learned that he had been in the company's employ as a machinist for over fifty years, or nearly the entire life of the firm, and others told a story of continuous service for like periods of time.

The originators of the firm, who have so long been identified with its name, were John and S. W. Putnam, who, previous to 1835, had been employed in some of the Lowell cotton mills as machinists. About 1835 they came to Fitchburg and established a small shop for repairing cotton machinery and any other line of medium machine work. The need of better lathes than those they could buy led them to build some for themselves, and as a demand was created, for the public. When the building of machine tools for the open market was under consideration, they removed to New Jersey, but soon returned to Fitchburg, in which city they have since remained.

John Putnam was essentially a workman, and his main interest was to produce the best work possible, and the set of gages shown in Fig. 16, made by him fifty years ago, testifies to his ability as a machinist. S. W. Putnam was undoubtedly as fine a workman as John, but possessed the additional faculties of the designer and business man, and to his and his descendants' management of affairs is due the long life and prosperity of the firm.

It is worthy of note that a grandson of the founder of the firm is at present works superintendent, a handing down from generation to generation of a machine business which smacks more of English customs than is usual in America. A degree from a prominent New England engineering college is one of the superintendent's possessions and a great aid in his life work.

Fig. 1. Main Machine Shop, with the Office showing in the Left Center.

Fig. 2. Main Foundry, Stable and Small Shops.

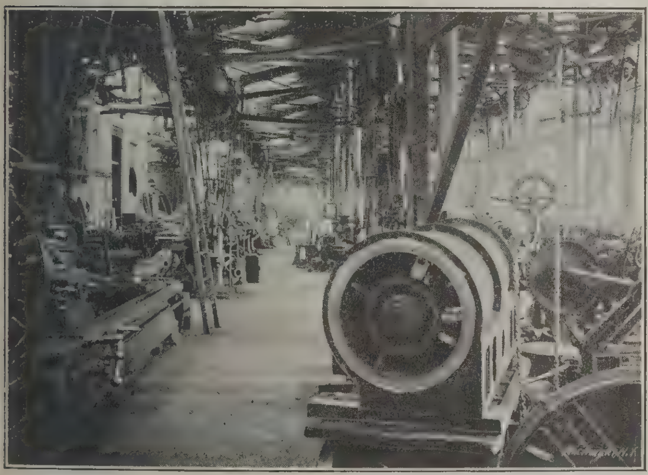


Fig. 3. Main Aisle of Machine Shop, looking from Opposite Offices.

Fig. 4. Ox Team used for Moving Materials, Castings and Machines about the Yards and to the Railroad.

The firm builds both light and heavy machinery for general machine shop equipment, but is best known from its heavy machines used so generally in locomotive shops. Its driving-wheel lathes and car-wheel borers are of the largest, and of the highest quality, as are its planers and large engine lathes.

In illustrating such a plant as this for the benefit of mechanics, an attempt has been made not only to show the place as a whole, but also to give an idea of how the work of construction is carried on in the shops. In this, only the larger work has been considered, as the small and medium machine work is much the same as everywhere, and it is in the heavier work that originality obtains.

Figs. 1 and 2 are exterior views of the works and the yards

* For additional historical notes on the Putnam Machine Company, see article under same title in the October, 1897, issue.—EDITOR.

of the company taken at one setting of the camera, but looking first to the left of the main avenue, and then to the right. The main machine shop is of single-story construction, lighted

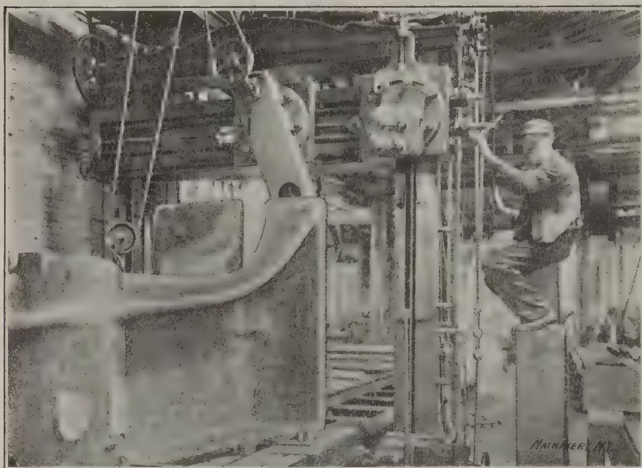


Fig. 5. Planing and Milling a Large Casting at one Setting on the Platen.

Fig. 6. Portable Boring Machine at Work. Radial Drill at Work in the Background.

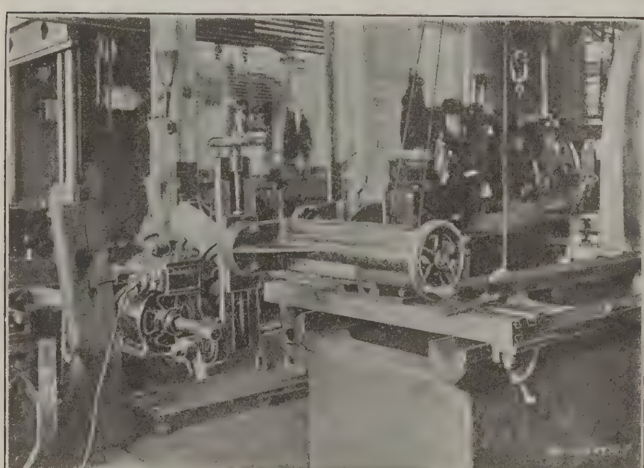


Fig. 7. Motor-driven Portable Milling Attachment for Finishing the Ends of the Ways.

mainly from roof monitors, which are placed at short intervals from each other, and the interior is in this manner lighted very uniformly. The transparent material used in the monitors transmits a yellowish light, very soft and pleasant to the eye, but a horror to the photographer on account of its lack of actinic rays.

Fig. 3 is an interior view, looking down the main aisle. To the right of this aisle the entire length of the main shop is devoted to the lighter machine work, largely lathe work. To the left is a double row of larger machines, mostly lathes. This much occupies about one-half of the width of the shop for its entire length. The remaining longitudinal half is divided into a series of small rooms by brick or other walls. Each room is open toward the main aisle, is provided with heavy machine tools, individual cranes, and is used for the heavier machine work and for erecting the heaviest machine tools. The outer or wall ends of these compartments open by means of wide doors upon the main yard avenue, making the receiving or delivery of machines and castings an easy matter.

Fig. 4 shows one of the industrial railways in general use at these works. There are several of these around the yards and shops. The engineer of the one shown, Gilbert LaPrade, says they are the best ever, and a look at their faces will convince anyone of their intelligence and honesty.

Fig. 8. Portable Boring Mill at Work Boring the Shaft Boxes on a Large Planer Bed.

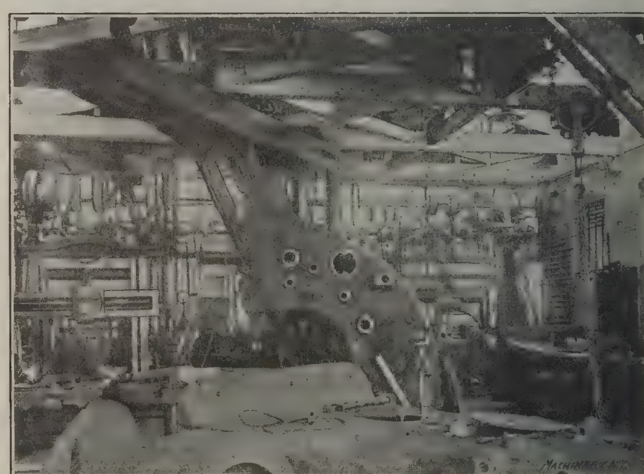


Fig. 9. Frames of Car-wheel Borers under Gib Cranes. Radial Drilling Machine in Background at Work on Casting.

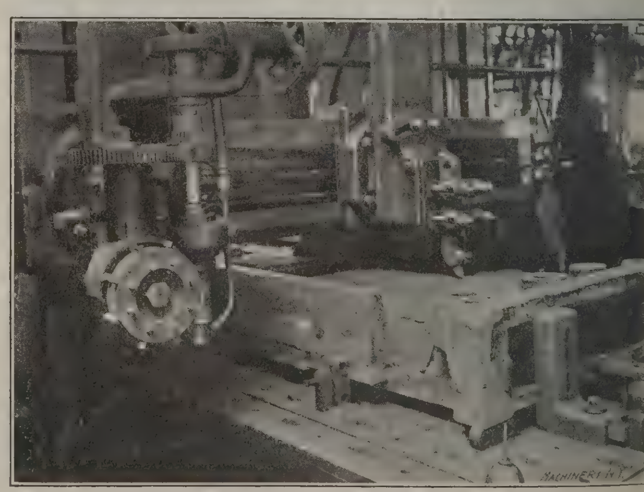


Fig. 10. Planer Fitted with Milling Attachment.

When finishing heavy machine parts it is oftentimes cheaper to finish certain surfaces by hand methods than to move them onto a machine and then line them to the cutting tool. This

leads, naturally, to devising methods of bringing the cutting tool into line with the work, or, in other words, it becomes easier to adapt the cutting tool to the surface to be machined than to take the surface to the tool. This often leads to using that most adaptable of all machines, human skill; or, as it is more often termed, hand-work. While the firm under discussion makes use of hand-work, yet a study of the illustrations, Figs. 5 to 11, will convince the reader that many things usually done by hand, or by setting on a machine, are better done by the use of portable tools, so designed as to be almost perfect in their adaptability. For example, in Figs. 6, 8, 9, 11, the drilling and boring on the heavy frames of a car-wheel borer is done by a portable boring machine which consists of

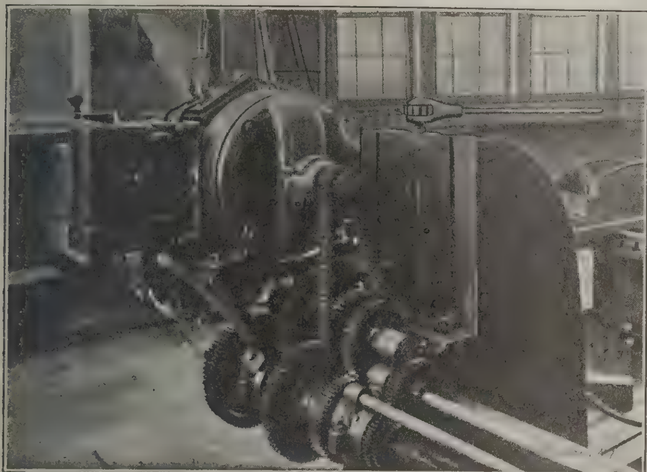


Fig. 11. Motor-driven Portable Boring Machine.

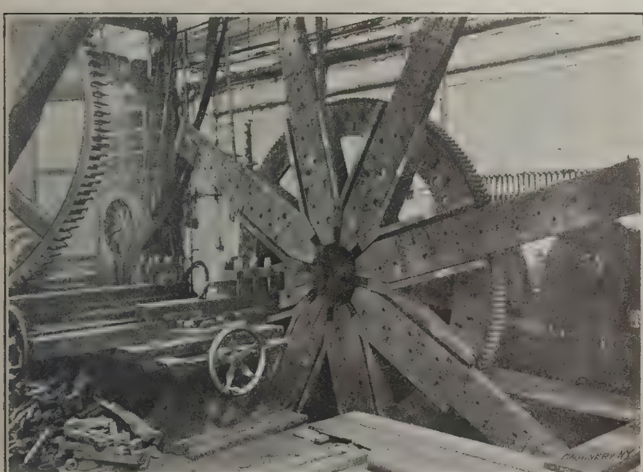


Fig. 12. Pit or Face Lathe.

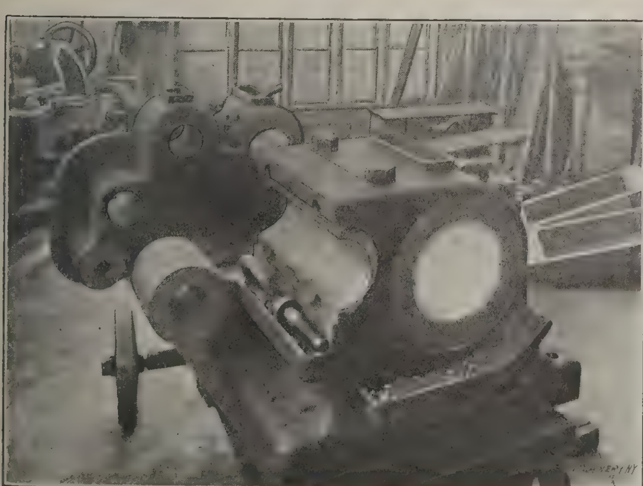


Fig. 13. Large Headstock Frame, with Babbitt-lined Bearings. Note Hammered or Peened Appearance of Left-hand Bearing.

an upright or housing which carries a rotating spindle or spindles geared to a variety of speeds. There is a vertical adjustment provided on the housing direct, and for a horizontal adjustment the housing is moved upon its base plate. As the boring bars are provided with universal joints, it is not necessary that the adjustments of the driving mechanism be special-

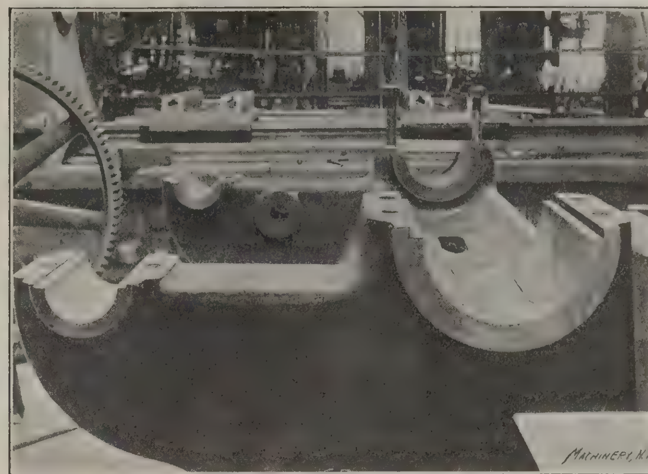


Fig. 14. Large Headstock Framed with Cast Iron Bearings. Note Oil Grooves.

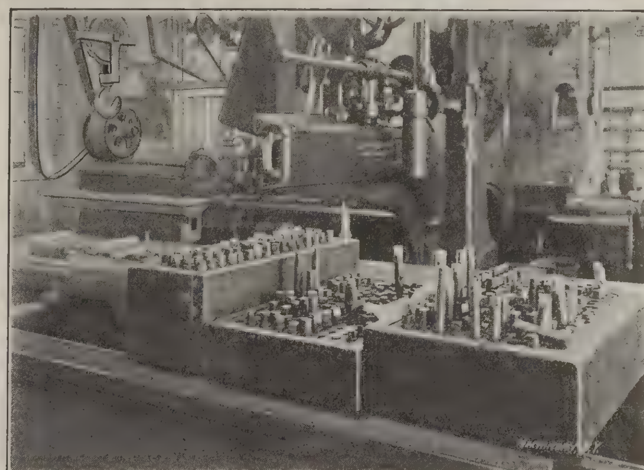


Fig. 15. Cases with Boring Bar Cutters.

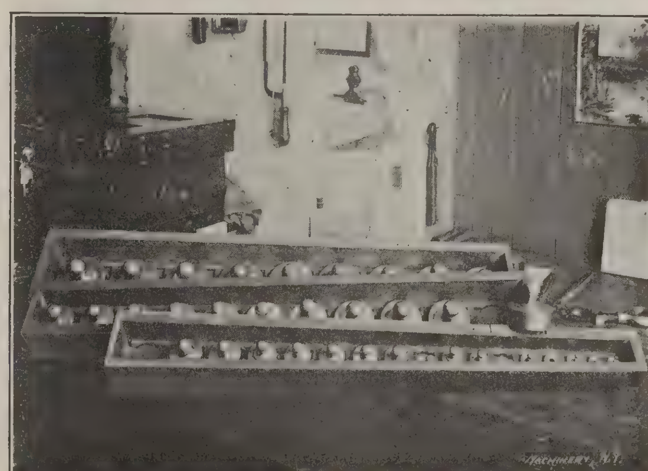


Fig. 16. Standard Reference Plug and Ring Gages.

ly accurate if the cutter bar be properly supported and guided by bushings or jigs. It will be noted that some of these portable machines are belt- and some are motor-driven.

In Figs. 5, 7, 10 are shown special milling devices contrived to do away with the necessity of hand-work or of shifting the position of the casting. Much labor is saved by the use of each of the pieces of portable machinery shown.

In Fig. 12 is shown a large and extremely old-fashioned pit or face lathe used to face off large diameters and incidentally used to do any job that fails to fit elsewhere. In the heavy machines built by this firm two kinds of bearings are used, as shown in Figs. 13 and 14. Fig. 13 illustrates a bearing lined with babbitt metal. It will be noted that one of the

bearings in this cut was unfinished when photographed and shows the hammer marks of peening the lining into contact.

In Fig. 14 is shown a plain cast iron bearing, and the oil grooves to distribute the lubricant. The spindle fitted to this bearing has a low rotative speed, but the pressure per inch of projected area is considerable.

Fig. 15 shows the method of storing the cutters used in the boring bars. It will be plain from the various views that there is a large amount of boring bar work, and that many cutters are needed. These cutters are all marked for the size of hole they will bore, and stored in the cases as shown. Mention has already been made of a set of gages made by John Putnam as a set of test standards. Fig. 16 shows these in their cases. As shown, the plug is slipped into the ring and each individual piece is a plug and ring gage. These were made in the early days of the firm and have been the standard to which they have since worked. Two or more of the plugs of an aggregate size of some ring can be placed in the ring, and the fit appears to be perfect to-day, and I understand that this was one of the means used to test their accuracy while they were being made.

* * *

THE DEMANDS ON A GENERAL FOREMAN IN GERMANY.

Werkmeister Zeitung, No. 6, 1907, gives an example of what certain employers in Germany demand of a general foreman. A gentleman looking for employment received from the firm in question the following specifications regarding his duties, and the following questions regarding his willingness to comply with the demands. In the first place, he was required to give his age, religion, conditions of military service, health, whether married or single, whether he had children, and how many, if he was employed at present or not, and if not, the reasons why; whether he would be willing to punctually follow the schedule of the shop from 6 A. M. to 7 P. M. in the summer and from 7 A. M. to 7 P. M. in the winter, excepting two hours for meals; to work overtime when necessary without extra compensation; to carry out on Sundays, before church service, such repair work as could not be done when the shop was running; to take care of the engines when the engineer was not present; to himself work at the bench when necessary; to see that all necessary requirements in regard to safety appliances were in good order in the shop, and to pay out of his own pocket any damages to employes hurt during work on account of lack of safety devices (the previous general foreman had done this). After this came questions regarding his experience and efficiency; whether he was able to personally, without help, take care of steam engines and boilers; to carry out personally in the repair shop all necessary repairs on machine tools, transmissions, steam engine and boiler, and plumbing work; whether he could independently make up cost estimates and lay out plans for smaller factory establishments; whether he was efficient in the caring for the electrical power and light station; if he was completely acquainted with dynamos, and could take care of accumulators; how long he had independently superintended the care of such apparatus; if he could make all necessary electrical repairs without help, and carry out extensions in electrical wiring; and finally if he was fully acquainted with the establishment of telephone and signal systems and with electrical elements.

It is said that the gentleman looking for the position made up his mind not to aspire to the job in question. It is, however, to be regretted that the German firm seeking for so efficient a man has not been able to communicate with the "General Engineer and Electrician" of English origin whose advertisement for a remunerative job we could not refrain from presenting to our readers in the March issue of MACHINERY, Engineering Edition, page 384. This little note and that go very nicely together, and, in view of it all, how futile seems the expression that this is an age of specialization!

* * *

Don't forget that some machinists can do more and better work with a \$2.75 kit of tools than some others can do with \$100 worth of tools in morocco cases.

THE LINK MOTION OF THE HANNA RIVETER.

There are two essentials in rivet driving with portable tools, or with any other kind of tools for that matter. These essentials are, first, that the work be done expeditiously, and, second, that it be done effectively. The first requirement is favorable to the pneumatic riveter in some of its forms, while the hydraulic type has decided advantages over the pneumatic machines, as usually constructed, when the second consideration is taken into account. Among the general types of portable riveters may be mentioned the "simple hydraulic," the "hydro-pneumatic," the "pneumatic lever" and the "pneumatic toggle joint" varieties. In the plain hydraulic type the die is driven forward by the direct pressure of a ram or piston, under a compression of from 1,500 to 10,000 pounds per square inch. The full maximum power for riveting is obtainable throughout the length of the stroke, and the pressure applied to the rivet is known and unvariable. For disadvantages, the trouble and expense of maintaining hydraulic packings might be mentioned, as well as the difficulty of using flexible joints in piping for fluids under high pressure; the power supplied

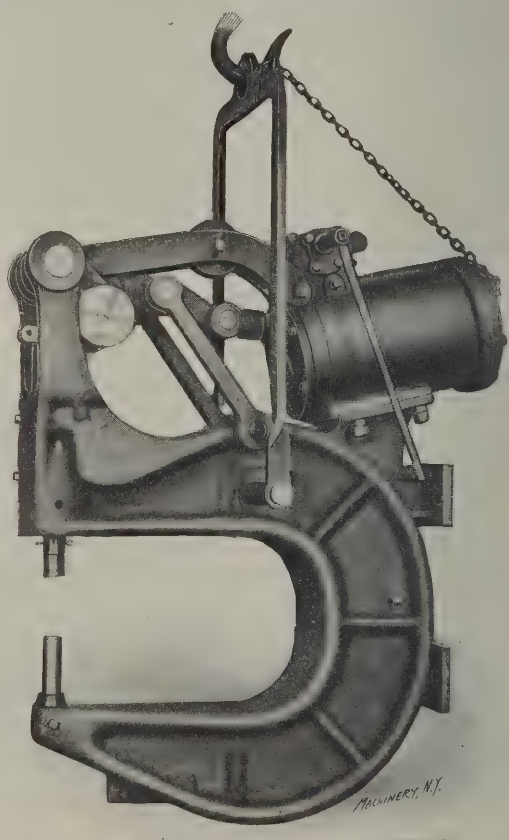


Fig. 1. The Hanna Pneumatic Riveter.

is also used in a wasteful manner. The hydro-pneumatic scheme employs the same direct connected piston, operated at will, however, either directly by air at low pressure or indirectly by high fluid pressure obtained from a self-contained intensifier. This is as effective as the plain hydraulic machine, but has the same packing difficulty, with the added aggravation that a slight leakage of air into the high pressure chambers renders the machine inoperative. The pneumatic lever machine is operated by a simple lever connected to the ram at one end and to a piston rod at the other, with a pivot between them. This device has the advantages of the hydraulic machine without its disadvantages, and works very well for small rivets. When, however, it is applied to ordinary structural, bridge and boiler work which requires rivet pressures ranging from 50 tons to a possible maximum of 100 tons, the diameter of piston required to furnish this with the usual working pressure of 100 pounds per square inch, is so bulky as to make the machine heavy and clumsy beyond the limits of a portable machine.

The toggle joint type is the one usually adopted. In this machine the riveting die is attached to one member of a toggle mechanism, of which the other member is joined to

the main frame of the machine, the piston rod from the pneumatic piston being attached to the center joint of the toggle and working at right angles to the movement of the die. This arrangement gives the desirable conditions of rapidity of action during the first part of the stroke and high pressure at the end. It is not possible, however, for the operator to know just what pressure he is exerting on the rivet. This depends entirely on the length of the rivet as compared with the distance between the dies when the mechanism is closed. Suppose, for instance, that a rivet has just been driven under proper conditions. With the die adjustment remaining as it was a second rivet is driven, the air pressure as in the first case forcing the piston to the extreme limit of its travel. The operator has now no assurance that the pressure obtained is the same as in the first case—the rivet may be a trifle shorter. If he is trying to do careful work he will return the riveter to its open position, close the dies together a trifle by the screw adjustment provided, and give a second blow on the same rivet, repeating this until the piston is just barely able to complete its stroke against the resistance offered to it. This assures him that the maximum pressure obtainable has been reached.

The procedure just described is necessitated by the fact that the toggle mechanism does not give the maximum pressure until the extreme end of the stroke has been reached, so that a full stroke has to be taken every time, and the dies have to be adjusted to accurate length for each operation in order to be assured of obtaining the desired results. If it were possible to so connect the piston and the ram that the maximum pressure could be obtained for a considerable distance, say one-half or one-quarter inch, the stopping of the mechanism anywhere within the limits of that distance would assure the operator that proper pressure had been applied, and that the riveting was well done.

This desirable result is attained in the link motion applied to the riveter shown in Fig. 1; the line cut, Fig. 2, and the skeleton diagram in Fig. 3 will serve more clearly to explain the action obtained. The same reference letters apply to the

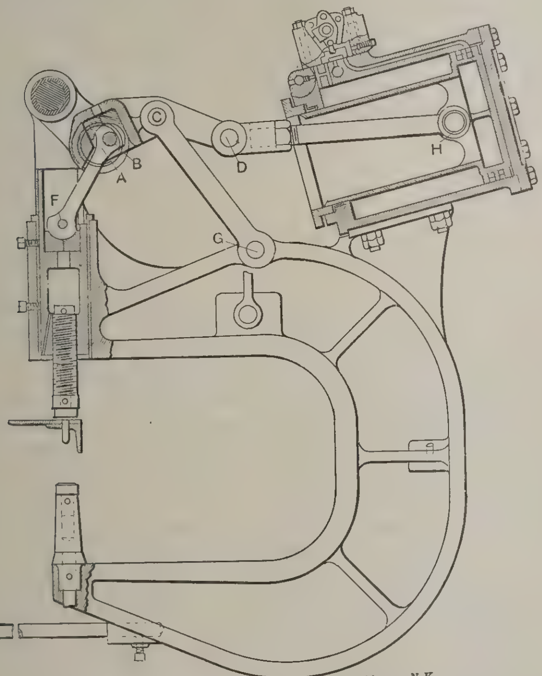


Fig. 2. Details of Construction of the Hanna Riveter.

same parts in Figs. 2 and 3. At H is the pivot between the piston rod and the trunk piston used in this machine. It is pivoted at D to the main lever, which is partially restrained in its movement by the guide links on each side, pivoted to it at C and to the frame at G. Projecting journals on each side of the main lever have their bearings at A in the upper toggle links, which are hinged to the frame at E. The lower toggle link seats in composition sockets with center lines at B in the main lever, and at F in the plunger.

The first position in Fig. 3 is that shown in the line cut in Fig. 2. **The second position of Fig. 3 shows the piston with** its stroke half completed. Of the 4-inch movement provided for the die, 3½ inches has been accomplished at this position; it is almost entirely effected by the toggle action resulting from the straightening out of links AE and BF. This movement was at first rapid, slowing up toward the end, when the maximum pressure available is reached. In moving from the second position to its third and final position, as shown in Fig. 3, the toggle movement has practically ceased, and the action is now that of a lever with power applied at D, with fulcrum at A, and with the working pressure taken from pivot B. Thus, the second half of the piston travel is entirely occupied

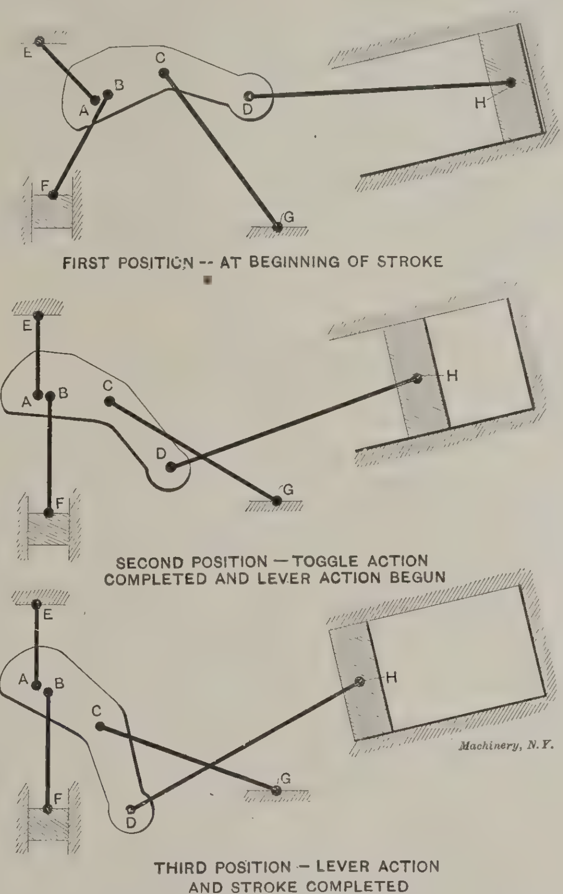


Fig. 3. Skeleton Diagram showing the Linkage Mechanism in three Positions.

in giving, by this means, the last half inch of steady maximum pressure of a known intensity, regulated by the size of the cylinder and the air pressure used. We have had the privilege of examining an aluminum model of this motion which shows its action very nicely. The piston in this model may be moved to successive graduations representing even inches of piston travel—twelve in all. Graduations on that part of the model corresponding to the plunger guide show the position of the plunger for each of these evenly graduated positions; the scale is reproduced in Fig. 4. It will be seen that

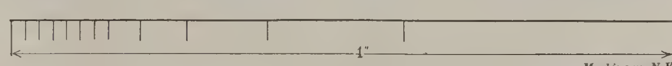


Fig. 4. Scale showing Successive Positions of Die for Even Divisions of Piston Travel.

the first 5 inches of the piston travel gives a constantly decreasing velocity to the die, while from the fifth to the twelfth graduations it travels with a nearly uniform velocity—a condition which, from well known laws, augurs a uniform pressure.

The advantages derived from this condition are easily understood from what was said in the opening paragraphs. On account of the considerable distance through which maximum pressure is exerted, careful adjustment of the die screw is not needed, and there is no necessity for striking a rivet more than once. Since the first half of the stroke of this riveting machine is identical with the full stroke of the toggle joint machine, the same care used in the operation will give the same results with considerably less air than is used by the latter type, a position which is further strengthened by the

fact that only one stroke is required even with the most careless working, where from 2 to 4 may be needed with the ordinary mechanism. Greater speed, also, naturally follows from the fact that but a single stroke is ever required, and that it is not necessary to make constant readjustments. As regards the matter of readjustment, it is possible, for instance, to drive a rivet through two ½-inch plates and then pass immediately to the driving of a rivet through three ½-inch plates without altering the position of the die; the pressure given to each of the two rivets will be the same. Finally this pressure is, as has been stated, predetermined in intensity.

The model previously mentioned is a fascinating piece of mechanism to operate. As the piston is moved down by the hand, the die is started rapidly forward, quickly arresting its motion, however, as the piston reaches the middle of the stroke; from there on its movement is slow and steady. This combination of toggle joint and lever actions, operating in succession without over-lapping each other's movement to any extent, shows ingenuity of a high order on the part of the originator of the scheme. The Hanna Engineering Works, of Chicago, build riveters using this patented mechanism.

* * *

MORE LIBERAL POLICY REGARDING THE AGE LIMIT OF EMPLOYES.

The age limit for employes hired into the service of the Pennsylvania Railroad Co. has been changed from 35 to 45 years. It was announced in the March issue of MACHINERY that President James McCrea would recommend that the change be made from 35 to 40 years, but at the annual meeting of the directors in March the change was made to 45 years instead. This change will be generally welcomed by industrial workers, for the policy adopted by this and several other large corporations a few years ago worked great hardship to many men, and was severely criticised. The placing of an age limit, however, was not a declaration that a man who had reached 35 years was unfit for future service, but it was simply the logical outcome of adopting a pension system under which all Pennsylvania employes are compulsorily retired when they reach the age of 70; they may voluntarily retire between 65 and 70. The pension of an individual is based on his average wage for the ten years prior to retirement and his total years of service. Hence it follows that there must be a certain age beyond which men cannot be taken into the service in order that all may enjoy the benefit of the pension system. The change to 45 years will probably make some change necessary in the pension regulation. The difficulty in getting skilled workmen at the present time was undoubtedly one strong reason for making the change. Many of our best mechanics did not acquire their greatest ability until they were well along toward middle life, and in order to avail themselves of the services of such men, the large corporations will generally be obliged to extend their present age limits. It may be with some corporations that there will be a class hired into service outside the pension benefit scheme, and this, in effect, has already been in vogue with the Pennsylvania Co. The master mechanics were given the privilege of hiring emergency men over 35 years of age for a period not greater than six months. At the expiration of six months they were discharged, and if still required, were immediately hired over again. This subterfuge permitted many of the repair shops to keep in service men beyond the recognized limit and still not make them eligible to the pension benefit.

* * *

It has been interesting to note the behavior of the London motor omnibuses during the recent frost and snow, which has been the most serious test of this nature that has occurred in ten years. As might be expected on ice covered roads, horses could barely stand; motor omnibuses, however, were able to proceed on their way without much trouble. During the thaws alternating with the frost, of course, both horse and mechanical traction suffered, as the thawing snow on the hard under pavement produced a very slippery, skiddy surface. On the whole, the motor omnibuses came out exceedingly well during this cold period, and, it is stated, much better than any other class of public vehicle.—*Horseless Age.*

THREAD TOOLS FOR THREADS WITH ROUNDED TOP AND BOTTOM.

E. A. JOHNSON.

While the development of a correct United States or V-thread tool is a thing requiring a great deal of skill and patience, it is easy compared to the task of producing a tool for the round top and bottom thread, of which the Whitworth and British Association standards are the leading examples. In testing for accuracy, threads of this type are not only measured by gages and micrometers, but the curves must match the angle so evenly that when the male gage is tried in the female from either end, no difference can be detected. The difficulty attending this will be the better appreciated when it is known that some of the leading tap and die manufacturers of this country and Europe have failed in producing threads that would pass the British government's inspection.

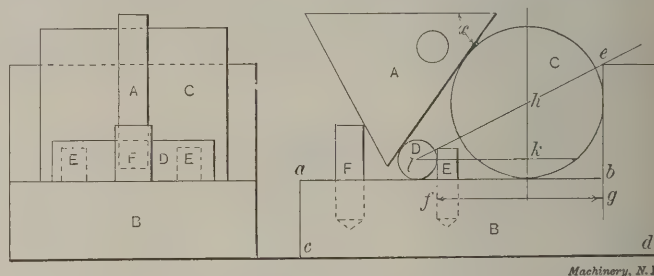


Fig 1. Method Employed for Obtaining 55 Degree Angular Gage.

It may be laid down as a cardinal principle that the best results are obtained by developing the form first with a flat top and bottom as in the U. S. thread, rounding the corners afterward. The first step of all is to produce a correct angle gage; assuming that we are to work out the Whitworth thread, this would be a gage measuring 55 degrees. Make and harden a steel triangle A, Fig. 1, with the angle x as near 55 degrees as is possible by using a bevel protractor; the other two angles are to be equal. Then make an angle iron B, making sure that $a\,b$ and $c\,d$ are parallel, and that $b\,e$ is square with $a\,b$. Assuming that C and D are accurate 2-inch and ½-inch plugs, we put in the pins $E\,E$ in such a position that a line drawn through the centers of C and D, at right angles to their axes, will make an angle of 27½ degrees with $a\,b$.

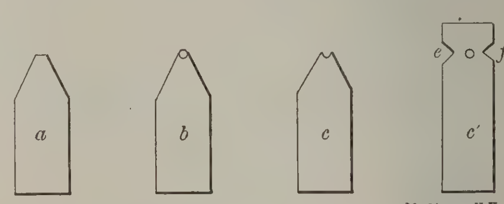


Fig. 2. Tools used for making Whitworth Thread Tools.

This can be done by figuring the distance $f\,g$ as follows: In the triangle $l\,h\,k$, $h\,k = 1 - 0.25 = 0.75$ inch.

$$l\,k = \frac{0.75}{\tan 27\tfrac{1}{2}\text{ deg.}} = \frac{0.75}{0.5206} = 1.4406 \text{ inch.}$$

$$1.4406 + \tfrac{1}{2}\text{ diameter of } C - \tfrac{1}{2}\text{ diameter of } D = 1.4406 + 1 - 0.25 = 2.1906 \text{ inch} = f\,g.$$

Set the pin F near enough to D to keep the corner of the triangle from striking the angle iron B. Mount the triangle A as shown, and set up the fixture on a surface grinder table using a toe strap in the small hole in A to hold it in position, and grind first one edge, then the other. This gives us the male angle gage. A female gage can be made to this by the method described in the January issue for U. S. thread gages.

The tools to be used in making the thread tool (see Fig. 2) include: an angular tool with a flat point, the width of the point to be such that it reaches to the center of the round in the bottom of the thread, the angle of the tool matching the gage previously made; a female radius tool for forming the point; and a male radius tool for the side radii. For convenience in measuring and getting the exact form required, these tools should be made with the top square with the face at the cutting edge, *i.e.*, without clearance. The sides and back of all should be ground as well as the top. The tool a

can be ground by means of an angular block made in the same manner as the male angle gage and should be finished by lapping. The tool *b* can be made in two pieces, one a hardened, ground, and lapped wire, and the other a soft piece made up in such shape that the wire can be soldered or otherwise firmly fastened to it in the correct position. The tool *c* should be made up first as at *c'* and hardened. Then lap the hole carefully to size and grind the outside. After measuring the distance from the hole to the back of the tool, the front can be ground off to *e f* and the bevels ground until the depth of the round part is right.

We now require a shaper with an apron made up to hold the tool-holder at an angle of 15 degrees, as shown in Fig. 3. The apron should fit the clapper-box perfectly. If it does not, it is better to fasten it solid, and let the tools drag back through the cut, sharpening the tools over again before finishing. Otherwise, one runs the risk of side shake. With this angular apron we can use the tools made without clearance to produce a tool with correct clearance for the lathe. Two thread tool blanks, one, *a*, of tool steel and one, *b*, of machinery steel, should be set up on the table adapter as shown in the cut with spacing parallels between to avoid interfering with one while planing the other. The blanks should be planed off to exactly the same height, and all measurements for height should be figured from the line *c d*, allowance being made for the difference caused by the 15-degree clearance. Then, after measuring the tools previously made carefully, to

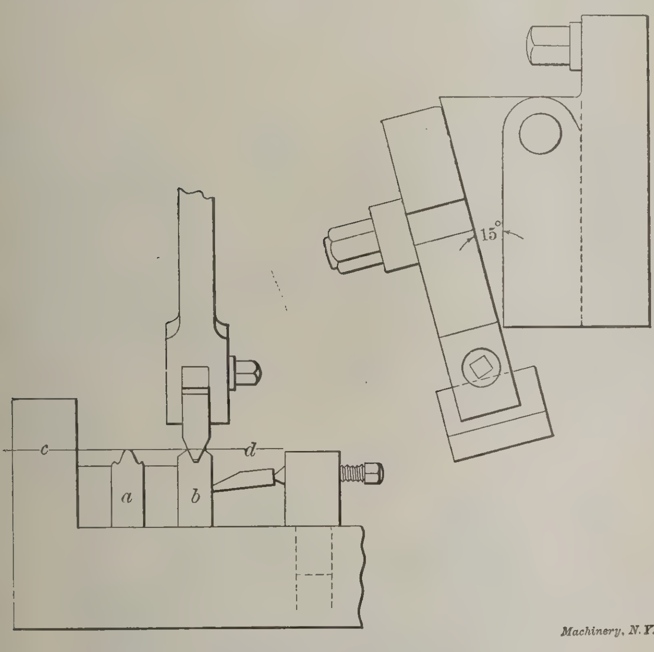


Fig. 3. Method of Planing Whitworth Thread Tools.

determine where the exact center is, we can start forming the blanks, setting the tools sidewise successively by positive measurement from the rib of the adapter. The angular tool comes first and with it we plane down the sides of the tool *a* and the center of *b* so that the point of the tool just reaches the center of the radius. Then using the female radius tool we round the point of *a* and the two points of *b*, coming down until the circle of the tool is just tangent to the top of the blanks. The male tool will round out the two lower corners of *a* and the center of *b*, being fed down to exact depth.

We now have the thread tool *a*, which can be hardened and the machinery steel blank used as a lap to correct errors in it, reversing the lap occasionally, and using oilstone powder or other fine abrasive as the cutting medium. Great care must be used in putting on the abrasive, as in all lapping operations of this kind points and corners are apt to lap faster than wide surfaces. This operation does not really correct the tool, but equalizes the errors due to imperfect matching of the different cuts, and it can be done so effectively that whatever errors of that kind are left cannot be detected.

To test the tool, turn up a blank plug with a teat equal to the diameter at the bottom of the thread. When this is threaded the point of the tool should touch the teat just as the outer corners touch the top of the thread. In the angle, the thread should measure by wires, as explained in the January issue, according to the formula:

$$\text{Diameter of screw} - \frac{1.6008}{\text{No. threads per in.}} + (3.1659 \times \text{diameter of wire used}) = \text{micrometer reading.}$$

For the final test of the fit of the curves with the angle, a tap must be threaded with the tool, and a female gage tapped with the tap. The plug made before must screw into this with an equal amount of friction from either end and show a full contact on the thread. If this last test is not successful it shows that the lapping is not good enough and must be done over. If the plug does not measure right it is necessary to go back to the planing and plane up another tool, making such allowances as one judges will correct the error. It is sometimes necessary to do this several times before a perfect tool is produced. In the use of the tool in the lathe, great care is necessary to see that it is set at the center of the spindle, and so that the two side curves will scrape the top of the thread at the same time. With the exception of making the angle gage and tool grinding block, this whole procedure has to be carried out for every pitch required.

* * *

METHOD OF REPAIRING CRANKSHAFT.

A correspondent to the *Scientific American* describes a method employed by him in repairing steel crankshafts of a compound high-pressure engine, 250 horsepower, used on a hydraulic dredge on the Mississippi River. The steel shaft 6 inches in diameter, broke about 10 inches from one of the cranks. The repair was made by facing the broken ends off square in a lathe and boring a hole in each piece 4 inches in diameter and 5 inches deep, and threading it 4 threads per inch. A steel plug or dowel 4 inches diameter and 10 inches long was turned and threaded the same pitch. The broken parts were screwed together with the dowel, the dowel having first been dipped in salt water so as to rust it fast. The work was done as an emergency repair, but it proved to be permanent. The dowel was threaded in a direction, of course, that caused the ends of the shaft to screw together under the impulse of the drive, the engine evidently not being of the reversing type. The shortening of the shaft, due to facing off the broken ends, did no harm. It was suggested by the correspondent that the friction between the outer ends of the shaft took up much of the torsional strain so that a comparatively small part was actually carried by the 4-inch dowel. Inasmuch as this repair was so effective, it was also suggested that the accepted method of connecting shafting in shops might be displaced by screwed ends. The shaft would be cheaper to manufacture and much neater in general appearance, having no flanged connections whatever. But even if such a connection were found reliable it would have the very serious disadvantage in case of a broken section, that each part of the lineshaft would have to be shifted endways several inches in order to replace the broken part, and this is enough to kill the whole scheme even if the actual connection were found to work satisfactorily—which we doubt could be the case.

* * *

The automobile industry has created a number of new occupations, previously unknown, but none, it might be said, more unique than that of the tester. His duty, says the *Horseless Age*, is to take the assembled engine with the very roughest equipment in the way of body and wheels, and thoroughly try it on the streets and roads in the vicinity of the factory. For ten hours per day, except when changing cars, the tester is at his post. To some people this would seem to be more or less ideal, and it undoubtedly is, in pleasant weather and in the absence of breakdowns, but the choice of weather does not lie with the tester, and the automobile industry does, as yet, not know of an engine designed that does not frequently break down. The tester makes in the course of a season an enormous mileage, and he learns every bit of the roads around the factory and all the neighboring towns and villages.

TWO GERMAN BEVEL GEAR SHAPING ATTACHMENTS.

There are evidences of unusual activity in Europe in the design and construction of gear-cutting machinery in all its forms. As further evidence of this activity, beyond what we have already presented, we illustrate herewith two devices of a kind not built, so far as we know, by any machine tool maker in America. These two devices are designed for planing bevel gears, and use templets or cams in giving the proper shape to the tooth. They are intended to be clamped to the shaper table.

The first attachment, shown in the halftone Fig. 1 and in the line cut Fig. 2, is built by the Act.-Ges. für Schmirgel- u. Maschinen-Fabrikation, Bockenheim-Frankfurt am Main. The attachment is fastened to the shaper table as shown, with bar *G* carefully aligned with the ram by an indicator or otherwise. The bevel gear to be planed is carried by the arbor shown. This arbor is rotated by the worm and gear in conjunction with the index plate. The worm and index plate are mounted in a quill in the head which allows them to swing about the axis of the arbor through a limited movement, independently of the indexing. The head *S* is bolted to a quadrant pivoted at *A*, about which as a horizontal axis, it may swing in a vertical plane. This swinging is effected by

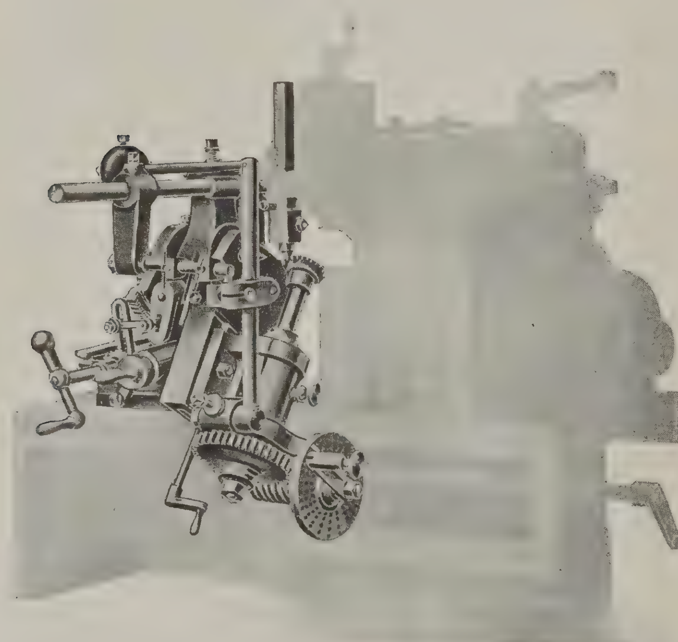


Fig. 1. Attachment for Finishing Bevel Gear Teeth in the Shaper by the Templet Process.

a quadrant having worm-wheel teeth cut upon it, meshing with a worm operated by the crank handle shown at the extreme left of Fig. 1. This crank handle may receive its motion from a ratchet feed arrangement actuated by the movement of the shaper ram. The bracket with its quill, which was mentioned as being journaled in the work spindle head and carrying the index arm and plate, has adjustably mounted to its outer end a post *B*, to which a holder is attached for carrying the templet it is desired to use. An outer arm *C*, suspended from bar *G*, carries a roll which is adapted to engage with the edges of the templet *D* and thus control the action of the blank with relation to the cutting tool.

In setting the machine for a roughing cut, a tool should be used a few thousandths smaller than the width of the tooth space of the bevel gear at the bottom. A pin at *S* is pushed in to lock the arbor-carrying sleeve with the head. The work is adjusted on the arbor until the elements of the gear blank converge at point *A*, the feed is thrown in, and the cut is started. The action is simply that of swinging the blank upward about point *A* until the proper depth is reached. In finishing, however, the templet *D* is used. The weight shown in Fig. 1 is swung either to right or left, depending on which side of the templet is being used. The copying roller engaging with this templet throws the post *B* over to one side more and more as the sector and the work are raised by the automatic feed, and the shape of the templet (allowance having been made for the shape of the roller and the tooth point) is reproduced on the tooth. The locking pin at *S* has, of course, been withdrawn during the finishing operations.

The machine is particularly flexible, owing to the manner in which the templet is supported. The templet may be moved toward or away from the center *A*, may be tipped to the right or left or may be raised or lowered. The article by "G. L. H."

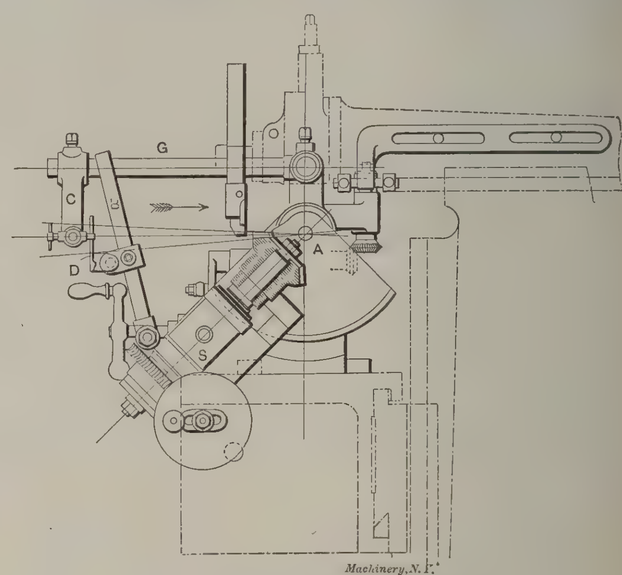


Fig. 2. Details of the Device shown in Fig. 1.

in the December, 1906, issue of MACHINERY entitled "Adjustable Former for Bevel Gear Planing," explains the way in which one templet may be used for various sizes of gears, if provision is made for locating the templet at any desired distance from the cone point.

The second machine, of which a halftone is shown in Fig. 3 and line cuts in Figs. 4, 5 and 6, is the invention of Prof. Moritz Kroll. The machine illustrated was built for his use in the Government Trade School in Pilsen.

The device consists of a frame *B* swung on pivots *Z Z* journaled in uprights $F_1 F_2$. The work spindle *A*, journaled in head *B*, carries the arbor to which the blank *R* is attached.

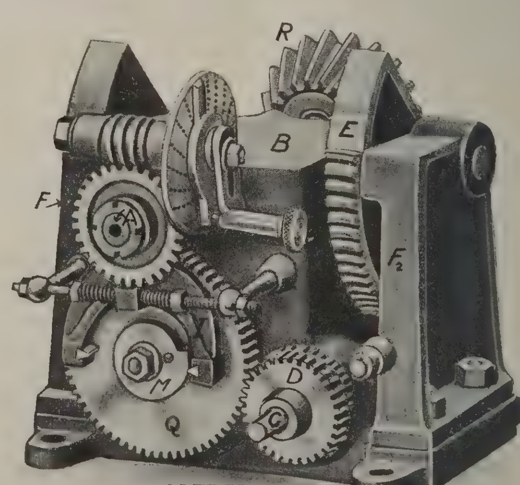
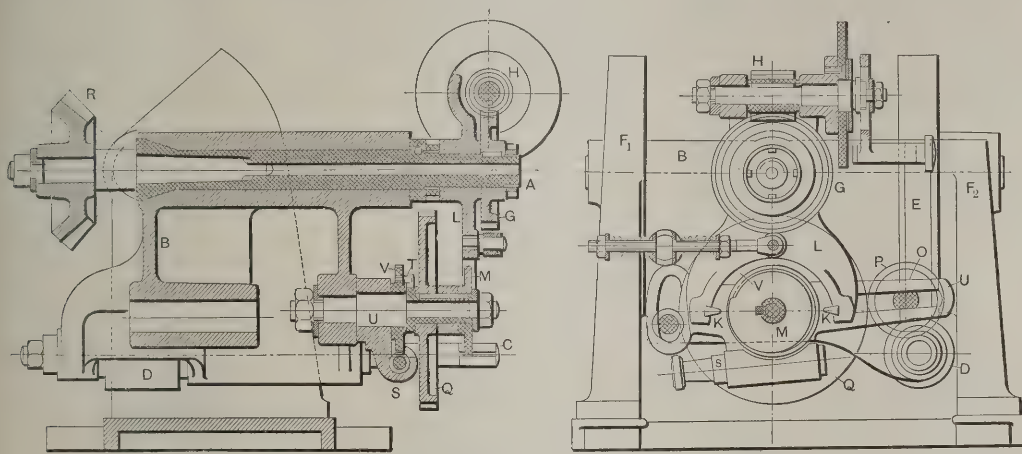


Fig. 3. Prof. Kroll's Bevel Gear Shaping Attachment.

The blank is so located on the arbor that the elements of its pitch cone surface converge on the axis of pivots *Z Z*. Spindle *A* is indexed by the worm-wheel *G* and worm *H* with the index plate shown. Worm *H* and its index plate are mounted on a loose bracket *L*, which has two outward extensions carrying hardened bearing pieces *K K*, which receive movement from the cam *M*. *L* is so connected with the double spring shown that either of the two blocks *K K* may be pressed on the cam *M*, depending on which side of the tooth it is desired to take a cut. Cam *M* is keyed to a sleeve which revolves

with gear Q. This gear in turn, through change gears, is connected with shaft C and worm D. Worm D engages a toothed sector E, which is fast to standard F_2.

It will be seen from this description that if a crank be applied to the squared end of shaft C and the proper direction of rotation be maintained, worm D and wheel E will give the blank an upward swinging movement toward the tool of the shaper on whose table the attachment is mounted. At the same time the connecting gearing D, O, P, Q will revolve cam M, which, acting through bearing block K and arm L, will give a slight rotary movement to the spindle, and the combination of the two movements will result in a curved tooth contour. If cam M has been skillfully made for any given tooth shape, we can depend on an accurate reproduction of the desired form for each tooth of the gear.



Figs. 4 and 5. Section and End Elevation of Kroll's Bevel Gear Shaping Attachment.

In the *Zeitschrift für Werkzeugmaschinen und Werkzeuge* for January 15, 1907 (in which the description appears from which our information is taken), Prof. Kroll has given a complicated mathematical proof of the proposition that it is possible (for a given pressure angle) by the use of change gears D, O, P, Q, to use one cam or former M for making involute bevel gears of any desired pitch, number of teeth, and cone angle within the dimensional capacity of the machine. It will perhaps be possible, however, by referring to Figs. 7 and 8, to understand how this is true without following the mathematical proof. Gears B and C in Fig. 7 have identically the same number of teeth and the same face angle; the diameters and the pitch of the teeth are different. Drawn in the position shown, however, it will be seen that the larger gear is but a continuation of the smaller one, so it is evident that both of them might be made at the same setting of the machine.

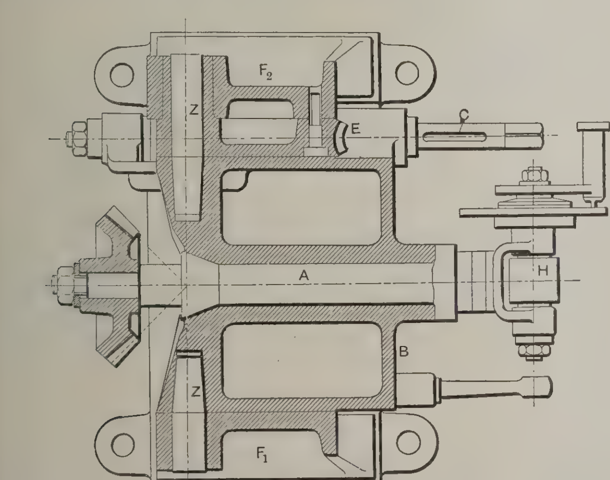


Fig. 6. Horizontal Section and Plan of Bevel Gear Shaping Attachment.

As is well known, and as was intimated in the article in the December, 1906, MACHINERY (before alluded to), the shape of a bevel gear tooth is ordinarily taken as equivalent to that of a spur gear having the same back cone radius. This radius, designated by Q in Fig. 7, is the same for both gears A and B of that cut. The angles of these two gears, however, and the number of teeth, are different. The pitch at the outer end of the tooth is also different, that of B being the greater. In the elevation between A and B, 2—0—4 is the tooth outline for gear B, while 1—0—3 is that of gear A. The latter is identical with the former so far as it goes, but owing to the fact that it belongs to a smaller tooth, it takes only a portion of the full curve. If a cam S, Fig. 8, were made to be used in the attachment just described of such shape as to give to gear B a tooth outline 2—0—4, using that portion of the periphery from 2 through 0 to 4, it is evident that, by using a correspondingly shorter length of the periphery (namely, 1—0—3), we ought to be able to produce the smaller pitch tooth of gear A. The angular movement of the blank about the axis of the work spindle required for this, however, will be greater in proportion than in the case of gear B, since the ratio of Q to the actual radius R_2 is greater. The necessary change is effected by the change gears.

We have now found it possible to make with the same templet gears A and C, although these two gears differ from each other in every possible point, both as to face angle, number of teeth, pitch, diameter, etc. It will also be evident that any other gear within the range of the machine may be cut, providing the proper change gears are used. A little thought will show that this principle also is based, though somewhat obscurely, on the idea described by "G. L. H." The advantage

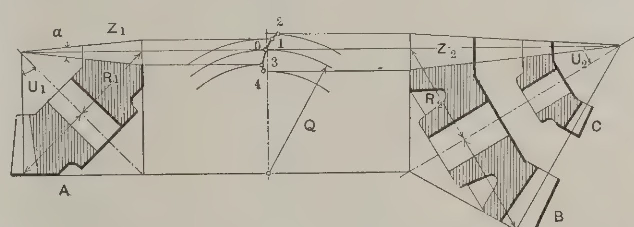


Fig. 7. Diagram showing the Shaping of Different Gears with the same Templet.

of this use of a single templet with change gears provided for varying face angles, is that a correct cam or former may be made once for all. When it is desired to cut a gear of a pitch and angle which has never been cut before, the purchaser of that gear need not fear the chances for error which would be present if the accuracy of the tooth form depended on the conscientiousness of the draftsman who made out the original curve, the ability of the workman who made the templet from the drawing, and the carefulness of the operator in adjusting the templet in the machine.

It is hoped that this description of these two German devices will stimulate some American manufacturer to do something along the same line, although most of them are probably busy enough already. The device might operate, like those described above, on the templet plan, or it might be a machine of the generating type. There ought to be a field for shaper attachments of this kind in medium-sized machine shops and on automobile repairs, for instance. In fact, we had an inquiry from a gentleman engaged in the latter business something over a year ago for some device of this kind. He asserted that he was unable to cut bevel gears on the milling machine so they would run quietly and smoothly enough for automobile work, and he hesitated some at purchasing the comparatively costly machinery necessary to plane them by the former or generating processes.

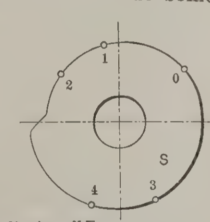


Fig. 8. Templet used in Cutting the Gears in Fig. 7.

CUTTING TAPER THREADED TAPS WITH CHASERS.

ERIK OBERG.

The cutting of taper threaded taps, such as pipe taps, with chasers is more or less common in shops where taper taps are manufactured, but the operation usually causes some difficulties. In itself the problem is very simple and the difficulty has probably originated in an insufficient analysis of the subject. We will consider the conditions of cutting a taper thread with a chaser, and particularly consider the case of

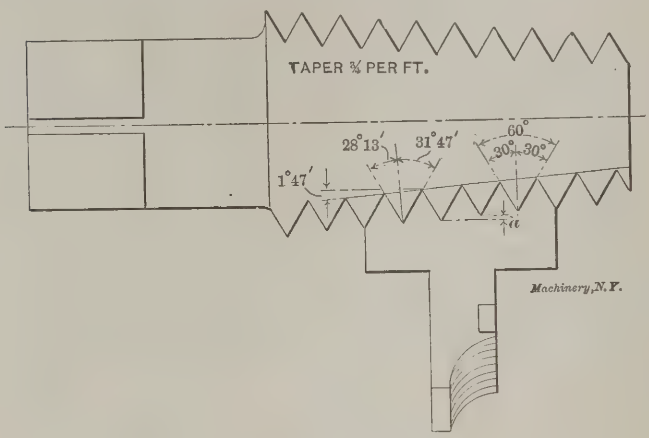
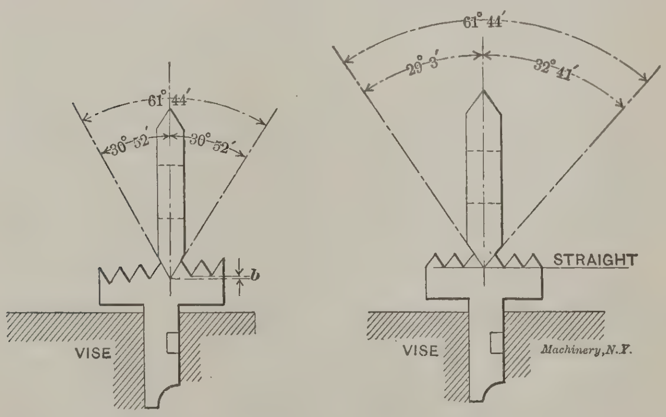


Fig. 1. Taper Tap Cut with Chaser made according to the Method shown in Fig. 2.

a pipe tap with a total taper of ¾ inch per foot, cut with a chaser supposed to be held in a threading tool-holder. In Fig. 1 a chaser is shown such as would be held in the threading tool-holder made by the Pratt & Whitney Co., this threading tool-holder being the most popular one and the one most exclusively used for ordinary threading. It is evident that if either a single point cutter or a chaser used for ordinary straight thread cutting were put in a holder and the holder swiveled around so as to present the chaser to the work at right angles to the outside of the tapered blank to be threaded, the thread formed would not be correct, inasmuch as a line drawn through the center of the thread perpendicular to the axis of the tap would not bisect the angle of the thread. This last condition, that the line perpendicular to the axis of the tap should bisect the angle of the thread as shown in Fig. 1, is the main requirement for producing a correct thread on a tapered piece. In order to produce such a thread with a chaser, the chaser must be made in a way specially adapting it for this class of work only. There are two



Figs. 2 and 3. Two Methods of Milling the Teeth of Chasers for Taper Taps.

ways in which such a chaser can be made, depending upon the way in which the chaser is to be presented to the work. In the first place, the chaser may be presented to the work perpendicular to the axis of the tap, as shown in Fig. 1, or the chaser may be presented perpendicular to the outside surface of the tap blank as shown in Fig. 4.

We will first discuss the former case. If the chaser were not provided with clearance it is evident that the milling cutter for milling the grooves in the chaser would be a 60-degree angular cutter, being 30 degrees on each side. The chaser would be held in the vise as shown in Fig. 2 and the cutter fed down, for each consecutive tooth cut, an amount depending upon the taper and the pitch of the thread. The values of a (Fig. 1) for pipe thread and other common taper tap pitches are as follows:

Threads per inch.	a
8	0.0039
11½	0.0027
12	0.0026
14	0.0022
18	0.0017
27	0.0012

However, as the chaser must be made with 15 degrees clearance, the milling cutter cannot be made 60 degrees, but must be made 61 degrees 44 minutes, this being the angle between the two sides of a single point cutter with 15 degrees clearance angle, if measured in a plane at right angles to the front face of the tooth. The arrangement for holding the chaser when milling, and the angles required for the milling cutter are shown in Fig. 2. The feeding down of the cutter will not equal a (Fig. 1) on account of the 15-degree clearance angle, but will be equal to $a \times \cos 15$ deg. This distance is shown as b in Fig. 2. The values of b for various pitches are given below:

Threads per inch.	b
8	0.0038
11½	0.0026
12	0.0025
14	0.0021
18	0.0016
27	0.0011

While b is, theoretically, different from a it will be seen by comparing the two tables that the difference is so small as to be insignificant for all practical purposes.

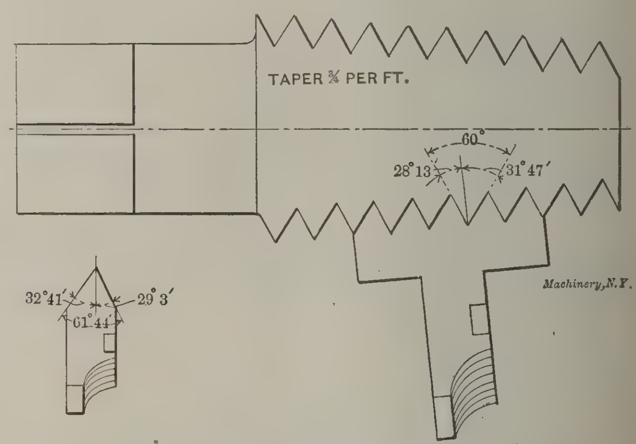


Fig. 4. Taper Tap Cut with Chaser made according to the Method shown in Fig. 3.

We will now consider the case where the tap is cut with a chaser at right angles to the outside tapered surface of the blank. We will find that in cutting this chaser with a milling cutter and holding it as shown in Fig. 3 we will not need to feed down the milling cutter for each consecutive tooth to be cut, but the milling cutter itself must be provided with different angles for the different sides of the thread. In Fig. 4 the actual angles of the sides of the thread with a line perpendicular to the outside surface of the blank are given as 28 degrees 13 minutes and 31 degrees 47 minutes, respectively, the sum of these angles being 60 degrees. The chaser being cut with 15 degrees clearance, these angles in the cutter will be 29 degrees 3 minutes and 32 degrees 41 minutes respectively, the sum of these two angles being 61 degrees 44 minutes. In Fig. 3 the manner of holding the chaser in a vise and the angles of the cutter are plainly shown. In the view to the left in Fig. 4 are indicated the angles to which to plane a single point cutter held in the same manner as the chaser and provided with a clearance of 15 degrees.

Care must be taken when making chasers to be used in the manner indicated in the first case that the elevating screw of the milling machine, by means of which the chaser is raised up toward the milling cutter for each consecutive tooth cut, is correct, and that no back lash enters as a factor in the operation. As this is difficult to insure against, it is advisable to cut the threads according to the second method, as there the chances of error are smaller, it only being required that the milling cutter is ground to the exact angles wanted, and that

the chaser afterward is presented to the work fully perpendicular to the outside surface. The angle which the face of the chaser in the latter case will make with the axis of the tap to be cut is 1 degree 47 minutes. This angle, however, would be difficult to measure unless the threading tool were held in a tool-post provided with some kind of a graduated swivel. In such a case a chaser could be placed so that its face would be parallel with the axis of the tap, clamped to the tool-post swivel, and this swivel afterward moved around in an arc corresponding to 1 degree 47 minutes. Ordinarily, however, if the tap blank is turned to a correct taper, the chaser can be set from the outside surface of the blank, its face being parallel to this surface in a horizontal plane through the axis of the tap.

* * *

A compressed air tank containing 15,000 cubic feet of air, and a dynamite magazine holding four tons of dynamite, exploded at Homestead, N. J., near the mouth of the tunnel the Pennsylvania Railroad is building under Bergen Hill, shortly after midnight, March 4. The tank was used for keeping a supply of compressed air for the tunnel, with which the tank was connected by a system of pipes. The explosion in the air tank, which occurred first, did very little damage except to the tank itself, but the detonation of the first explosion caused the dynamite in the magazine some distance away to explode. The two explosions took place only a few seconds apart and sounded as one, the hill back of the tank acting as a sounding board and causing the sound to be magnified to such an extent that the report was heard, not only in Manhattan, where it shook every building, but as far away as Coney Island and Whitestone, L. I. It is intimated that the probable cause of the tank explosion was improper lubrication in the air compressor. It is well known that the heat of compression may easily exceed the flash-point of cylinder lubricating oil, and if oil is used in quantity the condition is favorable to an explosion in the pipes and receiver. Such accidents are avoided by the use of soap-suds or graphite for lubricating the air cylinder.

A RAPID ACTION HYDRAULIC FORGING PRESS.

As most well-informed machinists are aware, there has taken place in the past ten or fifteen years a radical change in the methods employed in forging heavy work. This change has been, briefly, the substitution of the press for the hammer. With the increase in the size of forgings and in the hardness of the material of which they are made, there has come increasing difficulty in obtaining satisfactory results with the steam hammer. With the most powerful of these machines in use fifteen years ago, it was well nigh impossible to deliver a blow of such intensity that its effect would reach to the center of an ingot of the large size required for the heaviest marine and ordnance work of the period. A blow of ordinary intensity would merely deform the surface of the work; flaws in the center of the material might even be enlarged rather than obliterated. The increasing size of hammer necessary to produce the desired effect in forging reached its culmination in the great 125-ton machine, of which a model was exhibited by the Bethlehem Steel Co. at the Chicago Exposition. This great instrument, however, had scarcely commenced what was expected to be a long life of usefulness, before the process of hydraulic forging was found to be so far superior to hammering that the giant machine was relegated to an inglorious obscurity.

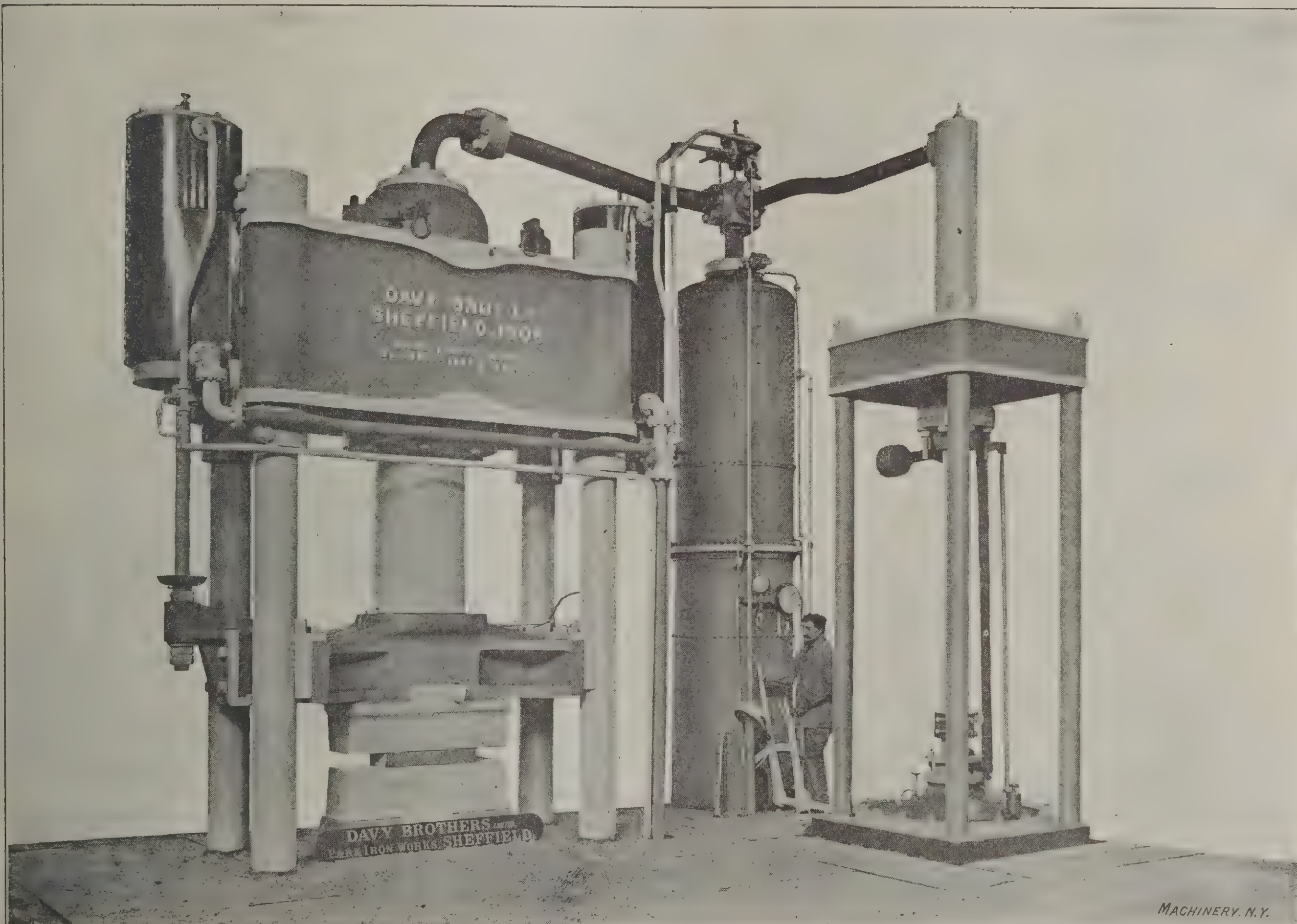


Fig. 1. Forging Press with Rapid Hydraulic Action.

The hydraulic forging press was first applied only to extremely heavy work. On billets and forgings of large diameter, the steady and tremendous pressure obtained from it is distributed through the whole mass of metal clear to the center, bulging out the sides of the work instead of merely making an impression on the surface which came in contact with the dies. This action works the metal throughout its entire volume, closes up all the flaws, and gives to every fiber the toughening effect produced by judicious working. But the slowness of action of the regular hydraulic press limited its use to large work, in which considerable time was of necessity consumed in handling the part being operated on and bringing it into position for a new stroke.

To obtain, on medium-sized work, the benefits of pressure

working as distinguished from impact working, a number of arrangements have been devised for giving a high speed to the ram in raising it from the work and lowering it again, with provision for exerting the desired heavy pressure as soon as the parts are in contact with the forging. Of these various arrangements one of the most interesting is that employed by Davy Bros., Sheffield, England. Applications of the idea to two forms of forging presses are shown in Figs. 1 and 3. The various parts are best seen in Figs. 1, and the line drawing of the same press in Fig. 2. The upper die, *A*, is attached to a cross-head *B* which has bearings on the four vertical tie rods. The hydraulic pressure is applied in cylinder *C*. *D* and *D* are two steam lifting cylinders for raising the ram. *F* is a combined air and water vessel adapted to store the water used in the hydraulic operations, and furnish it to the ram as desired for the quick movements, this being done by displacement due to a moderate air pressure. These operations are controlled by an automatic valve at *E*. *G* is the hydraulic steam under an auxiliary piston *N*, opens valve *E*, thus allowing the water in pipe *J* to escape into the water space of reservoir *F*. This reservoir has a lower compartment containing air under moderate pressure, but the steam in cylinder *D* furnishes sufficient force to return the water to reservoir *F* against the air pressure contained in it. The ram being thus raised for the insertion of the work, the operator returns lever *L* to its central position, when all valves are closed and the parts are in equilibrium.

The work being properly presented to the dies, the operator pushes the controlling lever toward the left. This movement first shifts piston valve *R* and connects cylinder *D* with the exhaust. The weight of the ram and die is thus left unsupported and they descend at the rate of about 2 feet per second, being helped along by the water under pressure in reservoir *F*, entering through valve *E*, which is arranged as a check valve and freely permits movement in this direction. As the die reaches the work, a further movement of handle *L*

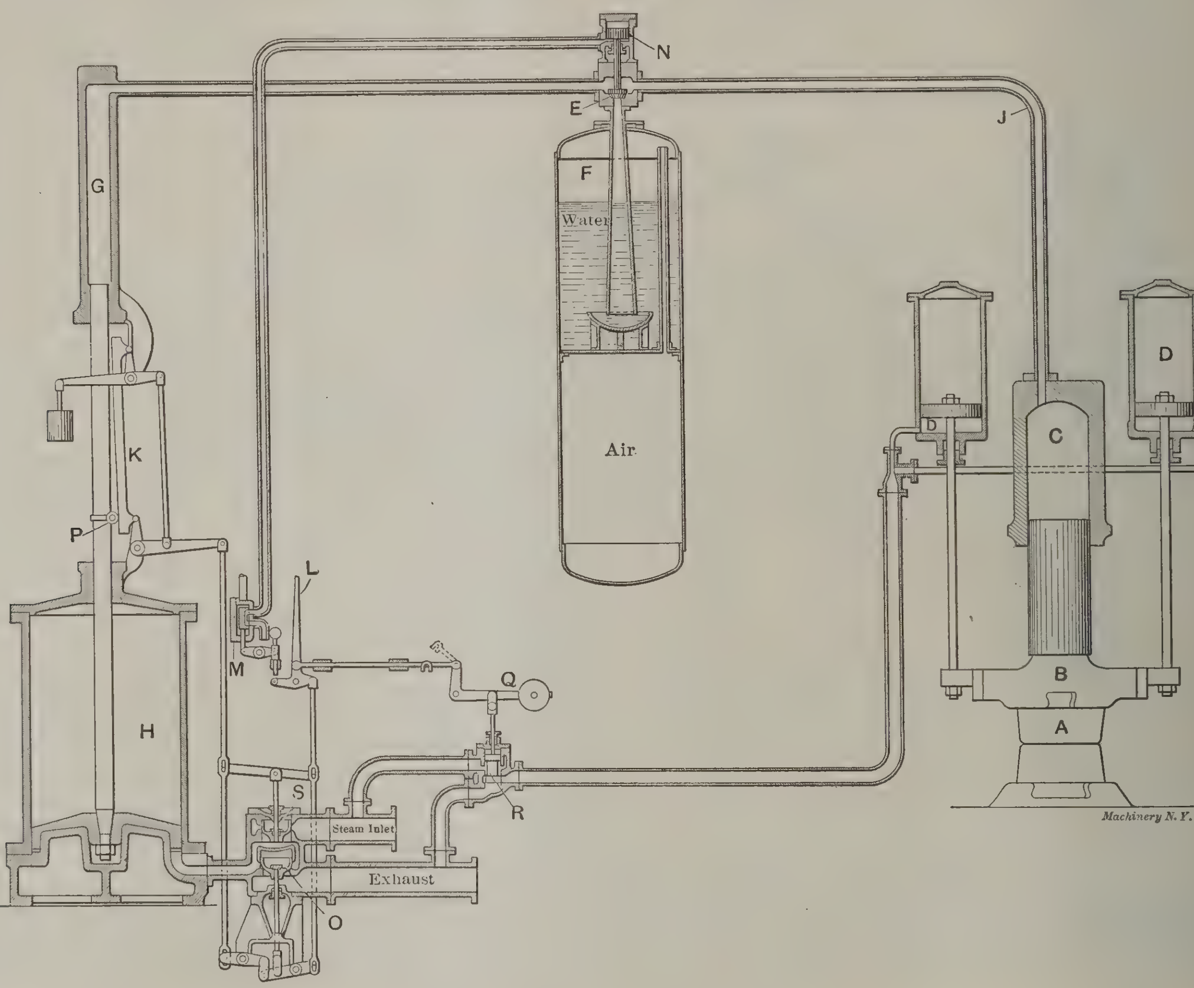


Fig. 2. Diagram of Forging Press in Fig. 1.

cylinder of the steam intensifier, whose steam cylinder is seen at *H* in Fig. 2, the main part of it being below the floor level in Fig. 1.

The operation of the mechanism can perhaps best be described by following the movements of the operator in making a single working stroke on a forging, starting with the ram in the position shown in Fig. 2 with the dies together. The movements of the press are controlled by lever *L*. The operator first desires to raise the ram *B* for the purpose of inserting the work. Handle *L* is pulled over toward the right. This opens valve *R*, first allowing steam to enter under the pistons in the lifting cylinders *D*. Ram *B* is thus raised, forcing the water contained in cylinder *C* back through pipe *J* into the water end of the intensifier at *G*. When the intensifier ram has been forced downward and the space above it has been completely filled with the returning water, the upward movement of ram *B* would have to cease, did not the operator continue to pull lever *L* further toward the right. This action operates a relay valve at *M*, which, admitting to the right, through the connecting mechanism shown opens the balanced poppet valve *S*, admitting steam to the under side of the piston in the steam cylinder *H* of the intensifier. The upward movement of the ram resulting from this, forces the water under tremendous pressure into cylinder *C* of the press, giving the movement and pressure required for the working of the metal.

This movement is under strict control, the length of stroke of the intensifier piston being limited by the amount by which lever *L* has been pushed over toward the left. This governing action is obtained through a floating lever mechanism similar to that used for water wheel governors, steering engines, etc. A bar *K* set on an angle is engaged by a roller *P* attached to the intensifier piston rod. The pushing of lever *L* to the left moves bar *K* toward the roll. As the roll travels up bar *K* it pushes it back again and the pushing back of this bar is transmitted through the floating lever to inlet valve *S* and exhaust valve *O*, operating them in such a fashion as to stop the movement of the intensifier at the desired point.

Provision is made for short rapid strokes under full pressure, for such work as rounding, swaging, cogging down, etc. By means of a lever shown in Fig. 1 at the operator's left hand, the connection between lever L and valve R may be severed. This condition is shown in Fig. 2 by the dotted lines, showing the link attached to the bell cranks raised. Weight Q, under these conditions, drops valve R, keeping the lifting cylinders D in constant communication with the steam pressure. Now if handle L be worked back and forth from the left hand to the central position, steam is alternately admitted and exhausted from the intensifier cylinder, whose piston travels up and down, alternately forcing the ram down and allowing the steam pressure at D to bring it back. Under these circumstances, the water under pressure in reservoir F is not used at all, since handle L is not moved to the right far enough to operate relay valve M. This rapid action brings the press into the same class with the steam hammer for operations of the kind referred to.

For smaller work, that requiring a pressure of from 150 to 200 tons, the single column type of machine, illustrated in Fig. 3, is used. In this the whole mechanism is self-contained as shown, the intensifier being mounted at the rear of the frame, which is hollow and serves as a reservoir for the water

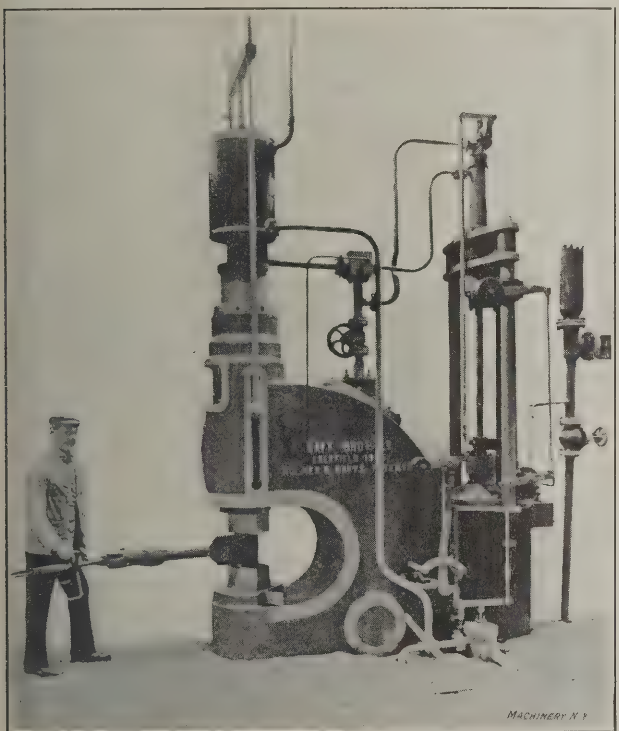


Fig. 3. Smaller Size Hydraulic Action Forging Press.

supply under pressure. The method of operation and the principle of the mechanism are, however, identical with that of the larger presses. The 150 and 200-ton machines will work 6 and 8-inch diameter ingots successfully. For the larger sizes, with the ordinary steam pressure of 150 pounds per square inch and water pressure of 2½ tons per square inch, the size of ingots which can be worked varies from 10 inches for the 300-ton size and 36 inches for the 1,500-ton size, to 72 inches for the 4,000-ton size. The smallest of these machines, working on short stroke, will make 80 strokes per minute with the reservoir F cut out and steam pressure on the raising cylinders as described, and with a machine as large as 1,200 tons, as many as 60 effective strokes per minute may be obtained. This great rapidity of action brings the hydraulic press well within the field of the small and medium size steam hammer. Such presses are somewhat more expensive than hammers of equivalent power, but the additional cost of the foundations for the latter approximately counterbalances this condition, so that the first cost is really about equal. Only about half the steam is required for the press, and it is much less liable to waste through wear and neglect. It has also the great advantage that the breakage of working parts is very small, and the tools can be made lighter and cheaper, and last longer.

NOTES ON ROLLING MILL DESIGN.

B. H. REDDY.

In the May, 1906, issue of MACHINERY appeared an article on "The Design of Billet and Bar Passes," in which was described a method by which such passes could be readily designed. In this article it is the intention of the writer to call attention to some of the conditions which must be taken into account when the design of bar rolls, passes, guides, etc., is undertaken, especially those for continuous mills. In rolling in mills where the piece is passing through from two to ten or more stands of rolls at one and the same time, difficulties are encountered that are not present where the piece is in only one stand at a time. In the latter case the piece is free to elongate, and the rolls can be driven at varying speeds without reference to any of the succeeding passes, while, in the first case, the diameters and speeds of the rolls and the reductions must be correctly proportioned and adjusted to each other.

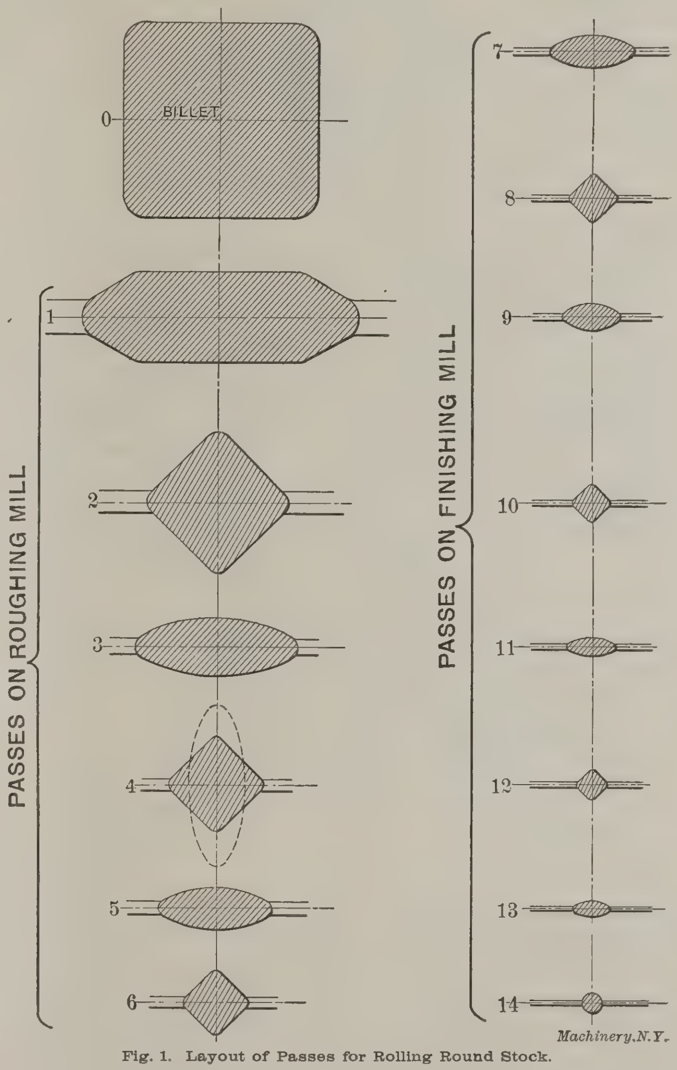


Fig. 1. Layout of Passes for Rolling Round Stock.

As the increase in length of a billet is directly in proportion to its decrease in area, this elongation must be taken care of in various ways. If the piece passes from one stand of rolls into a second stand whose peripheral speed is too great, there must be a slip of the bar between the rolls, or there is a likelihood of its parting if the section be small. Whereas, if the peripheral speed of the second stand be too slow in comparison with the speed of the first, it will cause a bow or loop of ever-increasing length, between the stands. This would cause trouble and could not be allowed. The different stands of rolls on continuous mills, especially on the roughing stands, where the speeds are the slowest, and the reductions the greatest, and consequently the heaviest strains are present, are usually driven by means of gearing from a main driving shaft, while on the finishing stands, where the speeds are considerably higher, the section rolled being small, and the strains comparatively light, belts are frequently used.

After ascertaining the sections to be rolled down and the dimensions of the finished product, the number of passes may be fixed and the same roughly designed. These will then be the basis upon which the proportions of the driving gearing can be designed.

If the exact speeds required cannot be readily obtained by means of the gearing alone, the small discrepancies can be overcome by increasing or diminishing the diameters of the rolls, by altering the reductions or proportions of the passes, or by a combination of both methods. It is apparent that in a mill where the piece is passing through a number of passes at one time, care must be taken in the proportioning of the different parts, so that each pass, diameter of roll, reduction in gearing, etc., will bear the proper relation to the whole. In order that the remaining portion of this article may be more readily understood, a set of bar passes, designed to roll down a 1¾ x 1¾-inch billet into a No. 5 wire rod in 14 passes, will be used as an illustration and is shown in Fig. 1. This set of passes was designed for, and is in use on, a continuous rod mill, and may be taken as a typical example of this kind of passes. Referring to the cut, it will be noticed that after the first pass, squares and flat ovals alternate, and the reason why this is necessary will be explained later. In ordinary box passes for the rolling of flats, etc., where the thickness is small in comparison with the width, there is very little tendency for the bar to spread sideways. By a "box pass," is meant a pass where the collar of one roll works in a corresponding groove in the opposite roll, thereby inclosing the pass on all sides. In the style of passes used in the illustrations, care must be taken to design the passes so there will be no tendency for the rolls to choke or to form "fins" on the bar as shown in Fig. 2. These "fins" are frequently the cause of considerable trouble and annoyance, and not infrequently cause the rejection of the finished product. Where a "fin" is formed it is rolled back into the bar at the next pass. If this takes place on a continuous mill, unless the fin is too pronounced, it is not likely to cause much trouble, as the distance between the stands is comparatively short, and the bar so well covered by the guides that it has no chance to cool. It is therefore rolled back into the bar without detriment to the finished product. However, on a mill where the bar is rolled backwards and forwards, the last end of the bar out of the rolls being the first into the succeeding pass, the fin has an opportunity to cool sufficiently to prevent welding into the bar properly, and consequently produces a fine crack in the finished bar and causes its rejection. The bar in traversing the short distance between the stands on continuous mills, passes through a guide. This guide is usually of cast iron, flared or chamfered at the entering end, so as to more surely catch the outcoming bar. The opposite, or "delivery" end, closely approximates the shape and dimensions of the bar, and is set as closely as necessary to the rolls and directly in line with the next pass. As before stated, the distance between stands being short, the bar is forced into each succeeding pass, should it for any reason not "bite" at once. This is especially true in the case of the heavier sections. Again, it would not be practicable to produce bars by rolling down only one way; *i. e.*, the bar must be turned frequently through an angle of 90 degrees. In the set of passes accompanying this article, this is required between the 1st and 2nd, 3rd and 4th, 5th and 6th, etc., passes. In mills where the bar is entered into the next pass by hand, no particular attention need be paid to the shape of the section, but in mills where this is to be done mechanically, this must be taken into account. Generally speaking, this is accomplished without the necessity of moving parts, by means of what is known as "quarter turn" or "twist" guides. These are used whenever the bar must be turned before entering the next pass, and differ from the ones previously described, in that they are given a twist, so the bar on being forced through will be delivered in a vertical position, as shown by the dotted lines on pass No. 4. By looking at the passes illustrated, it will be clearly seen that a flat or flat-oval section will be more easily turned by the guides than a rectangular one as the guides can get a better hold upon it. In order to facilitate the removal of "cobbles," as bars are called that have become twisted or entangled in the rolls, guides, etc., these parts are made so as to permit of ready removal. The guides are made in halves, held together and in place by means of key-bolts. The roll-housings are also designed with the same object in view, so that in case of a "mess," the guides can almost instantly be taken out and the rolls raised or taken out without much loss of time. The points mentioned are of prime importance and must not be overlooked by the designer, as a bar of hot steel, driven at a high rate of speed by heavy machinery, can twist itself into a greater variety of shapes and knots, and incidentally, cause more damage and loss of time and tonnage, than an inexperienced person would ever imagine, and the successful designer must have a practical knowledge of the conditions attendant upon the operation and repair of such machinery.

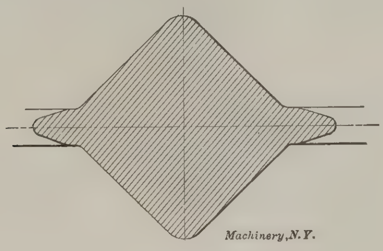


Fig. 2. Formation of "Fins" on Rolled Bar.

TABLE FOR THE LAYOUT OF THE PASSES IN FIG. 1.

Number of Pass.	Number of Grooves.	Center to Center of Grooves.	Diameter of Rolls.
1	4	3 in.	11.55 in.
2	4	3 in.	11.55 in.
3	4	3 in.	11.95 in.
4	4	3 in.	10.10 in.
5	8	1½ in.	9.80 in.
6	8	1½ in.	10.00 in.
7	8	1½ in.	10.00 in.
8	8	1½ in.	10.10 in.
9	8	1½ in.	10.10 in.
10	16	.8 in.	10.35 in.
11	16	.8 in.	10.25 in.
12	32	.4 in.	10.45 in.
13	32	.4 in.	10.70 in.
14	32	.4 in.	10.55 in.

* * *

An American corporation owning a meerschaum mine in New Mexico paints its possibilities in glowing colors in lately published literature, and intimates its willingness to unload 50,000 shares of the $6,000,000 capitalization on the dear public. Aside from this, and constituting the chief interest of the prospectus, to us, is some information regarding meerschaum. The present principal source of meerschaum is Turkey-in-Asia. The Turkish government has a monopoly of the output, and the price, ranging from $40,000 to $80,000 per ton, is steadily increasing on account of limitation of the output. In the dry state, meerschaum will float on water, but soon becomes water-logged. When wet it is heavy and may be cut like butter, but when dry it is the hardest substance in its mineralogical class, offering high resistance to cutting or crushing. It is the best known non-conductor of heat and electricity, and will absorb more nitroglycerine than any other known material. Not long ago it was used only for ornamental work, principally for pipes, but now it is being used for insulation in high-tension electrical apparatus. The high absorptive quality of meerschaum for nitroglycerine makes a new explosive possible which does not give off fumes or smoke, the meerschaum vehicle being far superior in this respect to the present absorbents used in making dynamite. Meerschaum is a valuable material for molds and can be regarded as absolutely permanent, even when subjected to the greatest heat. This, perhaps, is a valuable hint for the construction of molds for alloy castings that shall be absolutely true to pattern.

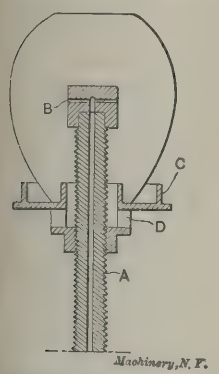
* * *

The Bulgarian authorities have a unique way of settling strikes. Recently the employes of the railways were on strike, and the authorities summoned all the strikers to join the colors, as they all belong to the army reserve. They were then drafted into the engineer corps, and detailed for duty on the various roads.—*Canadian Engineer.*

ITEMS OF MECHANICAL INTEREST.

NOVEL MANTLE FOR GAS BURNERS.

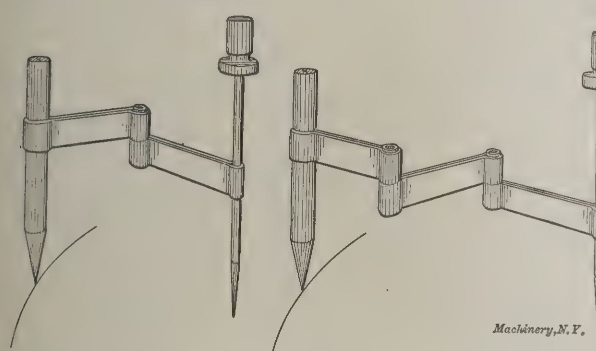
Industritidningen Norden describes a unique mantle, lately patented in Germany, in which the mantle itself consists of nothing else than an egg shell, this being, according to the patent specifications, particularly well suited for acetylene gas burners. The egg shell is converted into a glowing state by means of the combustion of the gas inside, and is said to spread a pleasing and agreeable light. The egg shell does not need any preparation whatsoever excepting the perforation of fairly large holes at both ends, as shown in the cut. Thus, one can oneself manufacture this mantle without any great experience or expense, and there may be a question as to the effectiveness of the patent. Referring to the figure, *A* is the connection to the gas pipe, *B* is the burner itself with small openings on the sides, *C* is a flange provided for holding the egg shell, and *D* the entrance for air.



Egg Shell used as Mantle for Gas Burner.

SIMPLE COMPASS FOR STUDENTS.

In a book recently received from Longmans, Green & Co., New York, was found a circular describing a newly devised pencil compass of very simple construction. It is shown in Fig. 1 in the "two-link" form and in Fig. 2 with the "three-link" arrangement. The first will draw circles up



Figs. 1 and 2. Simple Compass.

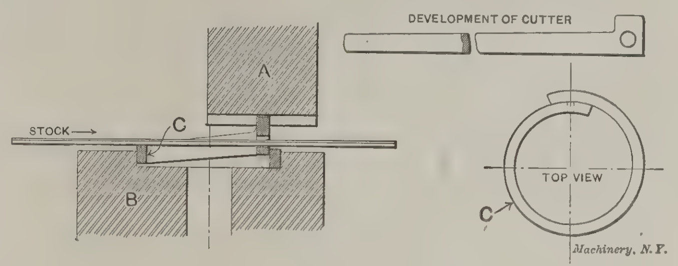
to $5\frac{1}{2}$ inches in diameter, the second has a capacity of $8\frac{1}{2}$ inches in diameter. The construction is so obvious as to scarcely need description. In this compass the pencil and the central stem are always perpendicular to the paper, so that any number of circles may be drawn from the same center without enlarging it to an unsightly degree. There are no screws to get out of order or get lost; an ordinary standard-sized drawing pencil may be used. The device is easily handled and the design is such as to lend itself to the construction of a strong, durable, and accurate instrument at a very moderate price.

NOVEL WIRE CUTTER—AN EXAMPLE OF NEAT DESIGN.

In a certain bookbinding machine it is required to chop off, very rapidly, short lengths of steel music wire. The first thing that would naturally suggest itself for this purpose would be a pair of shear blades, of which the movable one should be held by a sliding member traveling in guides. Other arrangements more or less costly would also be thought of, analogous, for instance, to the wire cutting device described in "J. T.'s" letter in the February issue. The form of cutting apparatus actually used is quite different from either of these, however, and a little thought will show that it is well adapted for the purpose it has to serve.

In the cut, *B* is the frame of the machine and *A* is the lower end of a vertically reciprocating slide which does the cutting. In *B* is a counterbored hole and in this counterbore is seated a cutter *C* of peculiar form, as shown detailed at the right. This cutter is made of a punching in two operations, being blanked and pierced in the first and bent in a partial helix in the second. It is then hardened and tempered, a great number of them being treated at the same time. In normal position the eye, as it may be called, appears above the tail of the contrivance as it lies coiled around snake fashion. When the ram comes down, however, this eye passes behind the tail, and the wire which is threaded through it is thus severed. The projecting head of the cutter is engaged by the slot in ram *A*.

It will be seen that this cutter is exceedingly cheap to make; this is important, for, whether cheap or expensive, its

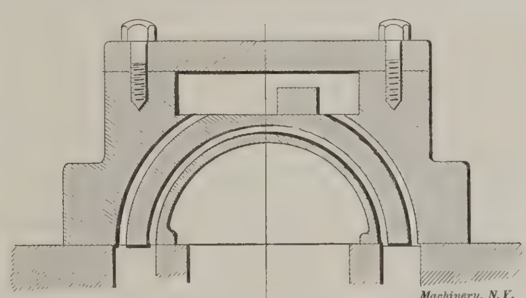


Device for Cutting off Music Wire.

life is a short one owing to the hardness of the material which it cuts. It can at once be replaced by simply lifting the slide *A*, reaching the finger into the counterbore to remove the old cutter, and replacing it with a new one. The wire is then started through the hole of the cutter, and the machine is again ready for operation.

REMARKABLE DEVICE FOR RELIEVING ENGINE CYLINDERS OF WATER.

One of the curiosities of a recent exhibit of safety appliances was a drawing illustrating what purported to be a relieving device for obviating the danger of breakage resulting from the presence of condensed water in the cylinders of steam engines. The accompanying cut is reproduced from a rough sketch which may not be exactly true in its proportions, but will serve to show the design of the appliance. What follows in quotation marks is a reproduction of the inventors specification written on the drawing.



Remarkable Device for Relieving Engine Cylinders of Water.

"The Slide Valve.—This slide valve prevents the cylinder heads from being knocked out when water gathers. When the valve is on its central position as shown, the pressure will be equal on both sides of the piston, thus giving the piston full play and thereby making a safe engine. The compression is adjusted by steam pressure." All of which is indeed illuminating. One's admiration grows as one studies the drawing. It would be interesting to know just what train of thought in the inventor's mind resulted in the production of this remarkable invention.

* * *

According to the *Cologne Gazette*, the widening of the Baltic ship canal will be shortly settled upon. The increase in width is intended to be very considerable, and will provide for the largest vessels afloat. The cost is estimated at $50,000,000, and as the work will involve new locks and drawbridges, it will practically mean a complete rebuilding of the canal. It is estimated that it will require seven years to carry out the enterprise. The progress of shipbuilding is amply expressed in the necessity of this increase of the size of the canal, which was opened only a few years ago, and then was built to provide for the largest vessels afloat at that time, and, in fact, had ample facilities for handling even larger ships.

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RAILWAY MACHINERY

A SPECIAL EDITION OF MACHINERY FOR THE RAILWAY SHOP, DEVOTED TO LOCOMOTIVE AND CAR EQUIPMENT AND MECHANICS.

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We solicit communications from practical men on subjects pertaining to railway machine shop practice, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

MAY, 1907.

The offices of Railway Machinery have been removed to the New York Life Annex, 49-55 Lafayette Street, four blocks north of City Hall Park and one block east of Broadway. The new offices occupy the entire eighth floor, of which a ten-year lease has been taken, and cover about 6,500 square feet.

* * *

ELECTRIC TRACTION ON RAILWAYS.

While there is no doubt that ultimately electric traction on steam railroads will prove to be as economical and safe as it is convenient and pleasing to the patrons of the railways, it is impossible even for the most ardent advocate of electrification to extract much comfort out of the statements made by the chairmen of the English railroad companies who have undertaken to electrify part of their roads. The *Railway Engineer* states that in one case the shareholders of a British railway were notified by the chairman that electric working is more expensive than steam working, and that at the present time most of the companies having electrified their lines are very much disappointed, in that the results have turned out to be considerably different from the estimates given to them by electrical engineers who were supposed to know a great deal about the matter. On the other hand, it was admitted that the cost of working electric traction is constantly being reduced, and that, while the cost is still far higher than the cost of steam traction, when we remember that electric traction on railroads is only in its experimental stage, there are still great possibilities. There is, however, a consideration in regard to the permanent way which cannot be too strongly emphasized. The electric rolling stock cuts the rails to a much greater extent than any stock that has been used in connection with steam power, and engineers are rather confused at arriving at any definite cause for it. It has been tried to overcome the difficulty by laying down hard steel rails, but the better way, by far, would be to, if possible, get rid of the cause, rather than to try to meet it by putting down a different kind of rail than has hitherto been necessary. We do not doubt that electric traction on steam railroads will prove a success in time, but the present results on English roads, where, for instance, in one case the half-yearly dividends on a certain section of the Metropolitan road were cut from 3 to 1 per cent, indicate that there is, as yet, a great deal of improvement to be desired.

* * *

STEEL CROSS TIES.

The recent derailment of one of the Pennsylvania Railroad's flyers at Mineral Point, Pa., on a portion of the track being laid with steel ties, has caused a great deal of comment in the engineering press. While the investigation of the accident seems to fully demonstrate that the steel ties had nothing to do with causing the derailment, the action of the management in removing the steel ties and replacing them with wooden ties would naturally give the impression that the railroad officials themselves were not perfectly satisfied with the steel ties. It is, however, quite as likely that these ties were removed for some other reason than that of less safety. As is well known, German railroads in matter of safety are considered to have reached a standard far above that of the United States, and in that country not less than 11,500 miles of track are provided with metal cross ties, this being more than one-fourth of the total tracks in Germany. As long as seventeen years ago 10,000 miles were laid with iron or steel foundation. The steel tie has thus had ample time for trial, and there is no reason whatever to think that under proper conditions the steel tie would not be fully as safe to use as would a wooden tie. There has been, so far, three objections raised to most of the existing designs of steel ties; first, that the method of fastening the rail to the ties is crude; second, that the steel ties have proven either too weak or too stiff, that is, that they have either failed themselves or caused broken rails; and third, the metal ties introduced the problem of insulation where automatic block signals are installed. On the other hand it is clear that these objections are not so great but that they can be overcome, and the steel tie will necessarily have to be considered in this country, and must receive here the same attention as it has received abroad, for many reasons. One of the most important of these is that the electrification of railroads, necessitating a third rail and its supports, the abolishing of grade crossings, calling for an abundance of viaduct work, and automatic train signalling, all call for stronger supports than can be provided by wooden ties. At the same time the growing scarcity of wood makes it an expensive tie material. It is unfortunate if the accident on the Pennsylvania Railroad has created the general impression that steel ties make railway tracks less safe for high-speed traffic. In view of the fact that the steel tie has been struggling hard for recognition in this country, after the satisfactory experience with it in Europe already mentioned, and in view of the great importance of developing useful substitutes for the conventional wooden tie, this erroneous impression threatens to work injury to a promising development in railroad practice. It may also be worth mentioning that the only objection raised by the officials of the Pennsylvania Railroad to the steel tie was that less injury to the track would have resulted if wooden ties had been used. The function of the track, however, is to carry trains safely on the rails and not to possess maximum resistance against injuries in case of railroad accidents. If track composed of rails bolted to steel ties is superior to track spiked to wooden ties, it is questionable whether the possible liability of greater injury to the track in case of derailments is a good argument against its use. At any rate it does not seem as if the matter of steel ties had been sufficiently tried out in this country to permit of any reflection being thrown upon this class of ties in so far as concerns the matter of safety of railroad travel.

* * *

An interesting improvement in steam whistles, of some importance to large manufacturing concerns, is an automatic valve which makes the operation of the largest whistles as easy as that of the smallest ones. It is well known that with the ordinary unbalanced whistle valve construction it requires a strong pull on the large sizes to unseat the valve. In time of danger when an inexperienced man, perhaps, attempts to blow the whistle to call out the fire department he may be so "rattled" as to be unable to sound the alarm. The automatic valve mechanism referred to is designed to prevent such occurrence and to make the operation easy for any one. It consists, essentially, of a small unbalanced disk valve of the usual style connected to the whistle lever, and of a larger disk valve connected to a piston. The small unbalanced valve connects with the cylinder in which the piston works. When the small valve is opened to blow the whistle, steam is admitted behind the piston and the pressure lifts the large valve, thus permitting a large volume of steam to escape into the whistle. When the small valve is released it closes, shutting off steam from the cylinder of the piston-operated valve, and a small constantly open port in the cylinder immediately lets the accumulated steam pressure release, whereupon a coiled spring and the steam pressure closes the large valve.

ONE AIM OF THE AMERICAN INSTITUTE OF SOCIAL SERVICE.

The American Institute of Social Service gave a dinner at the Aldine Club, New York, April 1, to about twenty representatives of the press and various professions. Stereopticon views of safety appliances used in Europe for the protection of industrial workers were thrown on the screen. Dr. W. H. Tolman, accompanying the views with a running description, told about the various permanent museums of security that have been established in Rotterdam, Munich, Berlin, Paris and other European cities. The institute is making a systematized effort to establish a similar museum of security in New York, and it already has a considerable number of models, photographs and other material as the nucleus of such an exposition. These were shown at the recent temporary exposition held in New York at the American Museum of Natural History in February.

Dr. Josiah Strong spoke at considerable length on the need of greater protection to life and men in this country and gave some appalling figures. He stated that as nearly as can be ascertained from our imperfect vital statistics and other sources, 525,000 men, women and children are killed and injured in the United States every year. In the words of President Roosevelt this number of casualties is equal to that sustained in a great continuous war. That is, we are continually killing and maiming as many people in peaceful pursuits as died by shot and shell in the four years of our Civil War, and to that number can be added the number of killed and wounded in both the Russo-Japanese war and our late Spanish-American war. Dr. Strong said that our manufacturers are not, in the main, hard-hearted and insensible to this terrible condition, but they largely lack the means of prevention. If improved devices and ways are pointed out to them by which the number of accidents can be reduced, they are, in general, only too glad to adopt them. In this connection he spoke also of the need of educating young factory inspectors to have an intelligent knowledge of improved safety devices and machine construction which would help to avoid many distressing accidents that are continually occurring. It is of little avail for a factory inspector to go to a manufacturer and tell him that certain of his machines are dangerous, unless he can point out how the defect may be remedied. If an inspector is able not only to point out dangers, but to suggest correctives, his position is greatly strengthened.

It is the aim of the American Institute of Social Service to bring about improved conditions in all branches of industrial activity, including mines, factories, railways, mills, etc., and while the movement is humanitarian, the appeals for improved conditions are made on a strictly business basis. No manufacturer needs to be told that accidents are very costly affairs. Not only may a valuable man be killed or crippled for life, but the effect on the other employes is always bad. Besides all this there may be suits for heavy damages, and the tendency to award heavy damages for industrial accidents is growing. From a political view it is important that the number of accidents be minimized. A crippled man is a pitiable object to others as well as himself. Brooding over his own maimed condition is very likely to make him hate capital and all employers of labor, and become an easy prey for anarchistic agitators. He is much more likely to become a danger to the community through the teachings of demagogues than a man able to earn a good living. A sentiment expressed which evoked general commendation was that we do not need more laws for the protection of labor so much as a lively appreciation that accidents are largely unnecessary and evidences of very poor business policy.

* * *

HOW TO GET ON WITH A SYSTEM.

One of the problems which a draftsman has to worry about, if he works for a big concern, is that of how to get on with the "system." Systems have come to stay. As businesses increase in size and unwieldiness, they cannot be managed by the rules and forms that governed them in the days of their infancy. Hence, we have blanks and forms and regulations and reports and orders, *ad infinitum.* The ideal way to attend to all these various matters is to have that part of the work dealing with the keeping of records, making of orders, etc., done by clerks, rather than by machinists; draftsmen, and others who are supposed to be engaged in more or less "productive" labor. In well-managed establishments there have been found ways to relieve the machinist of most of this worry and drudgery, but, so far, the draftsman has only seen his troubles increase from year to year. Conditions are such, as everyone familiar with the workings of a big corporation knows, that there is a constant procession of men flowing through the drafting rooms. Each day brings its new arrivals with "shining morning faces" eager for the fray, each having high hopes for the pecuniary rewards and increased experience which he is to gain from his new position; but each eve sees the silent and unobtrusive departure of as many battered wrecks who have found that, though competent draftsmen and designers, their nerves were unstrung and their equanimity wrecked by the strain of the pursuit of cross references, and the mad hunt for clerical errors, which the "system" imposes upon the draftsmen of to-day.

Seeing that the "system" has come to stay, he who has to do with it must make up his mind that he will learn to get on with it comfortably. In every establishment there are a few men who are efficient and ingenious designers and at the same time trustworthy and dependable followers of the system. What is the secret of this happy condition? We believe it may be expressed in this simple rule: *Whenever you do this, do also that.* In other words, couple each action, in making a drawing or a change on a drawing, with its appropriate action in relation to the system. Any draftsman knows that it is very unwise to neglect to pick up instantly a tool he has just dropped. He may want to wait until his pen is empty of ink, but before that time he is almost certain to have stepped on his spring compass, as it may be, perhaps, and to have ruined it beyond repair. He must associate the sound of the dropping instrument with the action of picking it up again. In like fashion the draftsman must analyze the system which he is using, and give to each action of his its appropriate clerical counterpart, and associate them in his mind indissolubly. If things are so ordered in the establishment with which he is connected, when he is changing the material of a casting from brass to phosphor bronze, for instance, he must *immediately* make the corresponding change on the stock list, or at least make and pass through the regular channels a note requiring that this change be made. When he has completed the drawing of a new part made from a casting, if his system requires it, he must *at once* make out the corresponding pattern order for having the pattern made. So it goes to the end. A moment's delay, a little folding of the hands to slumber, and the whole thing has escaped him; he is trusting to his memory; some things are forgotten, and some only half remembered. The longer this condition lasts, the more do his troubles pile upon him, until, finally, he finds that his job has run away and left him, and he has become the before-described battered wreck, who, with his bag of tools and reference books under his arm, slinks out of the door as twilight falls, never to return. Some time some wise man will find a way to let the skilled designer do his work with a mind care free from clerical details. Until then, eternal vigilance is the price of safety.

* * *

There are some shop proprietors who think that a foreman should be rushing about the shop continually, and who would at once conclude that he was not earning his money if they saw him quietly sitting at his desk planning out work for the next day or the next week, or even for the next month, as he ought to be able to do where the conditions are as they should be. This planning ahead is one fundamental feature of the Taylor system of works management, only it goes still further and relieves the foreman of the necessity of doing the planning, delegating that function to a planning department. Even the foreman, as he is generally known, becomes a nonentity, inasmuch as his position practically disappears, and is taken up by functional foremen who exercise only one of the many duties now assigned to the ordinary foreman, but that is another story.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

According to *London Answers*, Great Britain prides itself of the most expensive piece of railway ever constructed. On the London Underground, between Trinity Square and King William's statue, the construction cost is $5,000 a yard, which corresponds to $8,800,000 a mile.

The largest steam turbine as yet undertaken, according to *Industritidningen Norden*, is at the present time being built by Brown, Boveri & Co., Mannheim, Germany. This turbine is to develop 24,000 horsepower and is built for the Krupp Iron Works in Rheinhausen, where a steam turbine of 13,500 horsepower already is in operation.

On March 22, the House of Commons of Great Britain, by 150 to 118 votes, rejected the bill proposing to introduce the metric system into Great Britain. The president of the Board of Trade said in behalf of the government that the adoption of the metric system would prove a costly experiment to the country, and that Great Britain would lose the advantage which she possesses in certain foreign markets over her metric system competitors.

Lloyd's Register states that the world's merchant marine was, during last year, increased with about 2,158,000 tons. The increase in Great Britain alone was 764,000 tons, or about 35.5 per cent. If one considers only steamships with more than 3,000 tons displacement, of which in all 389 were built with a total of 1,788,055 tons, counting in those for the Great Lakes, not less than 81.5 per cent were built in Great Britain.

The most remarkable endurance contest for automobiles as yet undertaken, will undoubtedly be that between Pekin and Paris, concerning which the *Horseless Age* gives some information. No less than 18 cars have been reported to enter the contest. These vehicles have been shipped by railroad from Paris to Pekin, from which latter point the cars are to start. The route followed will be that along the Trans-Siberian Railroad, and the participants, who left Paris about April 15, are establishing supply stations along this road on their outward trip.

It is said that Secretary Taft is intending to appoint a committee consisting of architects, landscape gardeners and artists for the purpose of gathering material at Niagara Falls for a report looking toward harmonizing the commercial buildings, particularly the power plants located there, with the natural scenery. Such a step, if practicable, is undoubtedly one of importance, because too little has so far been done in regard to the preservation of the natural beauty of the falls, and too much has been given up to commercial consideration.

In comparing the rates of progress in the boring of large railway tunnels, says the *Mechanical World*, one finds that the Simplon tunnel, 12¼ miles long, was constructed at an average of about 28 feet per day. The Arlberg tunnel, 6⅝ miles long, progressed at the rate of 27.8 feet per day. The St. Gotthard tunnel, 9¼ miles long, was bored at an average of 14.6 feet per day. The 8-mile long Mont Cenis tunnel was built at 8 feet per day, and finally, the Hoosac tunnel, 5 miles long, progressed at the rate of 5½ feet per day.

Wireless messages sent from Washington, D. C., were lately received at Point Loma, Cal., a distance of about 2,400 miles clear across the continent. The messages were intended for Pensacola, Fla., but were distinctly intercepted by the operator at the California station. This is, as far as we know, the first instance in which a wireless message has been transferred across the whole continent, and probably the first instance of wireless messages anywhere having been interpreted after having traversed so long a distance of land.

An interesting experiment in the adoption of automobiles for traction purposes is at present being made in the Congo Free State. There is too little traffic to warrant the building of railroads, but fairly good roads have been built, and motor wagons make daily trips at a speed of about six miles per hour. When considering the slow speed, says the *Horseless Age*, it must be remembered that the road is not the paved street of civilization. If this experiment proves successful, it is intended to cut main roads for these motor wagons over the whole region.

The new terminal station at Hamburg, Germany, is one of the largest railway terminals in the world. The cost of the station and the work connected with preparing terminal facilities has amounted to more than $21,000,000. The main train shed has a span of 240 feet, a length of 580 feet, and a height of 118 feet, and is one of the largest glass-covered spaces in the world, covered as it is by 125,000 square feet of glass. Of special interest is the installation for facilitating the handling of baggage, which is transported to and from the platforms by means of wide, electrically driven, endless link belts.

The *Times Engineering Supplement* devotes a short note to the case of the steamship *Goldmouth*, a vessel which burns liquid fuel and which recently arrived in London after a passage from Borneo, a distance of over 12,000 miles without a stop. This is the third long distance non-stop run made by this vessel while burning liquid fuel, the first being from Singapore to Rotterdam in May and June, 1906, and the second from Singapore to Thameshaven in the fall of 1906. There is probably no other recorded instance of a single vessel having made three non-stop runs of such a distance with any kind of fuel.

A large project is under way for building a dam in the Connecticut River from Coopers Point, Hinsdale, N. H., to the Vermont shore in Vernon, a few miles below Brattleboro. The dam will be built of reinforced concrete on a solid rock foundation and will have an 800-foot spill-way. It will form a lake about eight miles long and a mile wide in places. The dam will develop a fall of 26 feet and it is expected that 12,000 horsepower will be made available for ten hours per day. The cost of the dam will exceed $1,000,000. It is proposed to sell power for local use at $25 to $30 per horsepower per annum.

It is claimed that the Pennsylvania R. R. has increased the efficiency of its freight cars in two years from 16.52 miles per day to 27.19 miles per day average movement. If this increase, which surely is badly needed when the traffic is as congested as it is at present, is due to the policy of the Pennsylvania R. R. to put practical railroad men at the head of its executive departments, it is an ample demonstration of what the railroads in this country will be able to achieve when the practical railroad man comes to his own, and stock jobbing railroad presidents are eliminated from our transportation system.

The *Monitor* first demonstrated the value of the turret in fighting machinery, and the promoters of the peaceful art of machine design were not slow to see its advantage, for the turret in machine construction has been fully recognized. Every year brings forth new machines making use in one way or another of the idea of a revolving turret, and Germany is the country where this idea has been made to serve a practical purpose for theatrical performances. The stage in a new theater in Berlin is placed on a revolving turret so that in a play of several acts, the decorations for each act may be of a more permanent character and, as the play is advancing, at the end of one act the turret will revolve and place the decorations for the next act in front of the audience, exactly in the same way as the turret turns around in a turret lathe, presenting a new tool to the piece held in the spindle.

A note in *Railroad Men* says that the Pennsylvania R. R. is considering a plan to substitute electricity for steam on its suburban lines, and whether the plan will be adopted or not will depend upon the report of a commission sent by the railroad to Europe to investigate electrification on railways there. This commission has recently returned, and it is understood that considerable information has been collected in favor of using electric power within city limits and on short suburban runs. It is understood that the report of the commission will recommend the motor in place of steam in spite of the considerable cost which the change from steam power to electric power for suburban service would involve. The resultant economies, it is declared, would warrant the step.

The electric cable manufacturing firm, Pirelli & Co., of Milan, Italy, whose experiments with high tension conductors we mentioned in our foreign notes in the January issue, are at the present time manufacturing cables which are used for 100,000 volt circuits. These cables are constructed in the following manner. The core of the cable is covered with a lead sheathing, then comes a layer of rubber about 0.100 inch thick, and two other layers of rubber about 0.100 and 0.180 inch thick, respectively. The last layer of rubber is covered with a layer of impregnated paper 0.200 inch thick. Lastly comes a layer of hemp and a lead sheathing which completes the electrical and mechanical covering. The thickness of all the insulated layers is about 0.600 inch thick and the outer diameter of the cable is nearly 2½ inches.—*Electrical Review.*

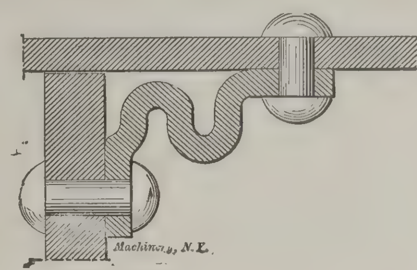
According to *Industritidningen Norden* experiments have been undertaken on the Prussian state railways in order to ascertain to what extent there is an actual saving in the use of superheated steam. There have been doubts expressed as to whether the use of superheated steam actually saves coal at all, because while the amount of steam is decreased, the amount of coal necessary for generating and superheating each pound of steam is increased. These experiments, however, show that there is a very decided saving in coal by the use of superheated steam. The following table gives the average result of the experiments:

Superheat, Degrees F.	Saving in Coal, Per Cent.	Saving in Steam, Per Cent.
68	5	8
104	9	12.5
140	12	16
176	14.5	20.5
212	17	24
302	24	34

The *Times Engineering Supplement* calls attention to the reluctance of large factory owners to rely upon single steam turbines as prime movers for their power equipment. While the advantages of the steam turbine are universally recognized, temporary breakdowns are, it is stated, still unpleasantly frequent. Leading turbine manufacturers therefore prefer to put down at least two tubines, each of half the capacity, instead of one of the full capacity necessary for driving the factory equipment. There will then be a better chance of having some power still available in case of breakdowns. One prominent British firm proposes that where two turbines are installed instead of one, each of them should be designed so that it would be able to operate at 100 per cent overload for at least a full working day of ten hours, so that necessary repairs can be effected on the other machine. There may be doubts as to whether this would be commercially expedient, and the proposed precaution is quite likely to increase the doubts in the minds of nervous buyers of power plants. The breakdown of machinery is a risk that must be expected by the owner of a small private installation, whether rotary or reciprocating engines are employed, but it is natural that the buyer will select that kind of engine which has been found by long usage to be the most reliable. For large power stations, however, where there is a great number of generating sets, there seems to be little doubt but what the steam turbine is far superior to any other steam power generator.

IMPROVEMENT IN LOCOMOTIVE BOILERS.

A French inventor, Mr. C. Frémont, of 124 Rue de Clignancourt, Paris, has patented an improvement for locomotive boilers which is shown in the accompanying cut. As will be seen, the tube plate is connected to the cylindrical shell of the boiler by means of a flexible angle iron, being corrugated or folded as shown. This flexible angle iron yields under the effect of the expansion of the tubes, and the lengthening of



Improvement in Locomotive Boilers.

these is made possible by the spring action of the corrugated plate, which thus relieves the tube plate of the boiler of all unnecessary strains. The angle iron is easily accessible, so that, if for any reason it should become cracked or damaged by the action of the expanding and contracting tubes, the damage can be immediately ascertained, and the angle iron easily (?) replaced.—*Mechanical Engineer.*

A SIMPLIFIED SYSTEM OF COMPUTING HORSEPOWER.

One of the technical writers of the *Horseless Age* has recently evolved a simple formula for the computation of horsepower. It may be expressed as follows:

$$\text{H.P.} = \frac{\text{Cubic capacity of cylinders (cubic inches)}}{10}$$

This simple formula is the result of extensive computations, and until recently it would not have been possible to make so general a statement. The horsepower depends upon the rotative speed of the crankshaft, but within the last year or two it has become almost universal practice to make 1,000 revolutions per minute the normal speed for all automobile engines. The other factors which enter into the familiar old horsepower formula, the mean effective pressure, length of stroke and piston area, are taken care of as follows: Piston area and length of stroke multiplied together give the cylinder volume, and the mean effective pressure will be found to vary but slightly in modern automobile engines, since practically all of them use the same grade of gasoline and approximately the same compression pressure. Therefore the horsepower of a modern automobile engine should be nearly proportional to the cylinder volume. The form of the combustion chamber and position of the spark plugs, of course, control to a certain extent the mean effective pressure; but in practically all cases the arrangement of the combustion chamber is the same, so that no attention need be paid to this matter when once the constant is established by which the cylinder volume is multiplied. This constant, as will be seen from the above equation, is one-tenth, and was determined as the result of a number of tests of various engines.

TRANSMITTING PHOTOGRAPHS BY ELECTRICITY.

Professor Korn of the University of Munich, Germany, has succeeded in designing an instrument for the transmission of photographic images over a telegraph wire. While many inventors have been working on the same subject for years, none has reached as practical results as has Prof. Korn. He uses selenium, as would be expected, as the basis of the instrument, and two motors move a corresponding mechanism simultaneously at the transmitting and receiving stations. The photographic film with the image which is to be transmitted is rolled on a glass cylinder. The cylinder revolves slowly and at the same time moves longitudinally. A ray of light from an electric lamp is made to pass through the film and the glass cylinder through a small hole in the front of the latter, and on account of the motion of the cylinder every point of the picture will be exposed to this ray of light. The

light, after having passed through the image is reflected upon a selenium cell, and according to the light or dark parts of the photographic film, the beam of light falling upon the selenium cell will have a greater or less intensity. These variations of light cause a corresponding variation in electrical resistance of the selenium cell, and as the latter is connected with a line through the batteries, a variable electric current is sent over the wire to the receiving station. The apparatus at the receiving station resembles the transmitting apparatus in many respects. We have here, also, a cylinder with a film moving exactly like the transmitting cylinder. The light thrown on this film through a small hole in front of the cylinder is modified in strength, by the variable electric current, by means of a galvanometer. This latter instrument, in fact, is the most original improvement of the Korn system. By the variations of light secured by the varying actions of the electric current on the galvanometer, an image like the original is produced on the film.

STEEL VERSUS WOOD.

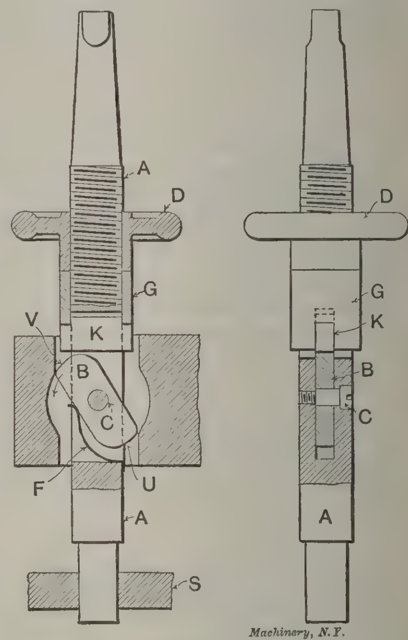
Iron Age, February 14, 1907.

The advance in the price of wood during the recent years has been so great that at the present time steel is cheaper than wood for structural purposes where heavy loads must be sustained, and if the constant, never receding advance of pine is to continue, as lumbermen predict it must, the time is not far distant when steel will be cheaper for all buildings requiring the strength that makes desirable the use of one or the other of the two materials. It is true that when the Panama Canal will be completed it will bring the Oregon and other Pacific coast timber closer to the markets of the middle and eastern parts of the country. A change in tariff relations with Canada may result in timber from our Northern neighbor being imported free of duty. But even then it is not likely that wood will fall very materially in price, and steel will probably even then prove cheaper for many purposes. To exactly compare the cost of steel with that of pine for structural purposes, two examples may be given. In one case a bay of a factory building 10 feet between beams and 20 feet span is to be supported by a beam either of steel or Southern pine. For the sake of convenience a standard 20-foot, 65-pound beam may be taken as a basis. The cost of this beam in a New England city would be $39.00. To attain the same strength with Southern pine under identical conditions, a beam 16 inches deep and 28 inches wide would be required, which means two 14 x 16-inch girders, the cost of which would be $41.00. Thus the steel would have $2.00 the better in the comparison. Taking a smaller size, however, say a 15-inch, 42-pound beam, the cost of the steel would be $25.20, as compared to $20.50 for the equivalent timber—a 14 x 16-inch girder. Taking everything into consideration, therefore, including the expert opinion of men well informed in the lumber business, there would seem to be little doubt that the tendency to substitute steel for wood in heavy mill or factory construction will constantly increase, not only because of the merit of steel as a building material, but because of lessened actual cost.

SIMPLE DEVICE FOR SPHERICAL BORING.

Zeitschrift für Werkzeugmaschinen und Werkzeuge, March 15, 1907.

When inside spherical surfaces have to be produced, the devices usually employed are more or less cumbersome. For this reason the device in the accompanying cut is greatly interesting, because it shows a very simple means of accomplishing what is generally considered as a more or less difficult job. The device shown can be used on the drill press as well as in the lathe. It is cheap and consists of very few parts. As shown in the cut the tool is intended for use on the drill press. When used in the lathe the tapered shank is done away with, and the spindle *A* is placed between the centers of the lathe, held by a dog in the same way as an arbor. The device consists of a spindle *A*, with a slot cut through it, in which is placed the cutter *B*, which is free to turn around its center stud *C*. A spring *F* holds the cutter in a vertical position so that one can pass the tool in through a drilled hole to the center of the work in which a spherical surface is wanted to be produced. At *S* is shown the table of the drill press itself through which is drilled a hole guiding the lower end of the spindle. Part of the spindle *A* is threaded, and on this part is mounted a small handwheel *D*. The thread on the spindle is left-handed. When the drill spindle turns, carrying with it the spindle *A*, the handwheel *D* is fed downward by slightly retarding its motion when turning with the spindle. When the handwheel feeds downward it presses on bushing *G*. This bushing in turn is fastened to the hardened steel key *K* which is also placed in the slot provided for the cutter, and which by the feeding downward of the handwheel *D* and the bushing *G* will press on the rounded corners of the cutter *B* and thereby turn this around its central pivot, forcing it gradually downward and thereby causing it to produce a spherical surface. The cut commences at the top at *V* as well as at the bottom at *U* at the same time, and the spherical form is completed when the cutter stands in a position nearly at right angles to the axis of the spindle. It is of course of importance that the cutting edges of the cutter are exactly the same distance from the central pivot *C*, as otherwise there would be a small ridge left in the center of the spherical surface.



Device for Spherical Boring.

VALTELLINA ELECTRICAL RAILROAD.

Teknisk Tidskrift, March 9, 1907.

Probably the first main line in the world using electric power exclusively for the regular traffic on long distance is the Valtellina Railroad in Italy. The electrical installation was carried out by Ganz & Co., Budapest. The current is three-phase alternating; the line has two parallel overhead wire conductors and has the third phase carried in the rails. The length of the road is 67 miles, of which 30 per cent is in tunnels, and nearly 50 per cent of the full length of the road is composed of curves. The maximum grade is 2 per cent, and the minimum radius is 1,000 feet. The road is laid with 80-pound rails placed on impregnated wooden ties, the rails being bonded with copper at the joints to provide for good electric conduction. The electric locomotives weigh 51 tons and have four motors of 150 horsepower each, using current of 3,000 volts. The ordinary passenger trains consist of one motor car and four to five ordinary passenger cars. The speed is from 40 to 45 miles an hour, which is maintained even on grades up to 1 per cent. The locomotives in freight traffic pull trains of 280 tons with a speed of 40 miles per hour, and 440-ton trains with a speed of 22 miles per hour.

The energy necessary per ton mile has been found to be with full speed on the level from 18 to 20 watt hours and in heavy grades from 34 to 55 watt hours. When starting a train to a speed of 40 miles per hour during a time of 2 minutes, about 150 watt hours per ton of train weight is necessary. The average energy required measured at the power station is 73 watt hours per ton mile, but in this is included all current used for heating, lighting, for the power required for the railway shops and all losses. At the power station the maximum load is nearly 2,000 KW. but the average load is only 700 KW.,

or slightly more than 1/3 of the maximum. The cost for the electrical installation is shown in the table below:

Power station	$600,000
Main conductors and transformers	200,000
Working conductors	360,000
10 motor cars, each $24,000	240,000
5 locomotives, each $20,000	100,000
	$1,500,000

The cost per mile is thus about $22,400 for the electrical installation alone. The operation costs for 1904 amounted to $300,000. The passenger fares are those common for express train service in Italy, which is 1.6 and 3.8 cents per mile respectively for third and first class. This installation is particularly interesting as it has proven the practical possibility of using the same train system for electricity as for steam on comparatively long distances. It has proven that electrical locomotives in all respects may replace the steam engines, and that the future of electricity for railroad power generation wherever the power can be had cheaply, that is, where waterpower is available, is secured.

ANALYSIS OF QUALIFICATIONS FOR PROMOTION.

The habit of analyzing every problem, separating it into its component parts, is one that distinguishes the thorough-going man from one who merely guesses at things. It is astonishing, to one who has not made it his habit to enter into analytical consideration of every problem presented, how readily some question of apparently complex state may resolve itself into simple parts when subjected to analytical inspection. And that a system of analysis can be applied to an individual, measuring his general ability and fitness for a position has some elements of novelty, even for the habitual analyst. In an article on measuring fitness for promotion by Mr. Joseph L. Gobeille in the *Iron Age*, the accompanying table is given by which a man can analyze his own or others' fitness or unfitness for a position. Of course the values assigned for the various items may not coincide with the individual ideas, but they will serve as a guide in the matter of analytical estimate of an individual. Mr. Gobeille says that in the United States there are literally thousands of openings for assistant superintendents, foremen, assistant foremen, and gang bosses, especially in Eastern and Southern mills and shops. These places pay from $1,000 to $3,600 per year, and besides the salary they carry with them very agreeable emoluments such as private office, stenographer, etc. The man whose ambition is to rise in the world will find the habit of analysis of the greatest value, and if he will apply it to his own case and see how well he lines up for promotion, it may result in strengthening some of the weak parts. In referring to the assignment of values to the various items, Mr. Gobeille says that from personal observation and actual data carefully noted for more than twenty years past, he believes that the nomenclature and division of qualities is sufficiently accurate to be used as a measure and may be safely followed:

a Practical knowledge of the trade, including ability to plan original work and lay down necessary drawings.	25
b Executive ability and initiative	20
c Abstinence from rum, beer and cigarettes	15
d Punctuality and prompt action	10
e General information and versatility	10
f Under 40 years of age	10
g American nationality	5
h Affiliation with some church	5
	100

HEAT LOSSES IN DRYING PROCESS.

In apartment drying where the material remains in the same position during the entire process, variation in treatment is secured by changing either the air volume or the temperature. The discharge temperature is then practically the same as that throughout the room. In the progressive plan, the air supply and temperature remains practically constant, while the material continually progresses from the cooler and relatively more moist portion of the room to that which is hottest and dryest. Under the conditions presented by either system there is a three-fold loss of the heat originally imparted to the air. First, that required to evaporate the moisture in the stock; second, that lost by transmission through walls and by leakage to the outer atmosphere; and third, that carried away in the air intentionally discharged from the room. The first, which measures the actual cost of drying only, is evidently an inherent part of the process and therefore cannot be reduced; the second, which is usually great, depends upon the character of construction, and in most cases could and should be materially reduced; the third loss is to a certain extent inherent, but may be kept at the minimum by maintaining the proper relations between air volume and temperature and the space occupied as the drying room, so that the utmost available drying capacity shall be utilized.

The conditions are clearly shown by the following results of a careful test of a special form of drying tower for removing the moisture from heavy cardboard. It was well built of brick; heated air was supplied under pressure by a Sturtevant steam hot-blast apparatus, consisting of fan and heater, and a portion of the air was returned through a galvanized iron duct and reheated in connection with a moderate supply of fresh air admitted from the atmosphere.

LOSSES OF HEAT IN DRYING SYSTEM.

Source of Loss.	Per cent of Total Heat
Required to vaporize moisture in stock	32
Lost by leakage, radiation from tower and unaccounted for	37
Lost by radiation from return duct and by introduction of fresh air at fan room	31
Total heat imparted to air	100

A portion of the heat was saved by using the return duct, as is possible under proper conditions, thereby cooling and condensing some of the moisture out of the air, and then passing it to the heater at a temperature considerably higher than that of the atmosphere. Had all of the air been discharged from the top of the tower, this loss would have been greater and the efficiency lower, but the higher the tower the better the opportunity of cooling the air to the lowest practicable temperature.

It is easily possible, particularly in a progressive dry room, to make the mistake of having the length of transit of the air over the material so great that the air, although saturated to only 70 or 80 per cent humidity at a relatively high temperature in the warmer portion of the room, becomes cooled below the dew-point before exit, and actually deposits moisture upon the material which is to be dried. Large volumes of air and shorter length of transit will overcome the difficulty.

STEEL RAILS AND THE PASSING OF THE BESSEMER PROCESS.

The Times Engineering Supplement, February 13, 1907.

The fact that the Bessemer process has already passed the zenith of its growth is one which has now become well recognized by metallurgists generally. In Great Britain the open-hearth processes of steel production have, as regards the yearly make, far outstripped the Bessemer process. Taking the British Iron Trade Association's published returns for the first half of the year 1906, it appears that the make of Bessemer steel is considerably less than half of the make of open-hearth steel. There are three main causes for bringing about the supersession of the Bessemer process, which at one time was justly considered to be the most perfect solution possible with reference to the problem of converting crude molten pig iron into steel. These causes are in the first place the growing scarcity of iron ores suitable for the Bessemer process; secondly, the superiority of the product obtained by the open-hearth process, and finally, the cheapening of the production of steel ingot made possible by modern methods. As regards the increased scarcity of iron ores suitable for use in the Bessemer process this is probably the most important of the three causes mentioned. The main English supply has for years been Spanish red ore from Bilbao, but this is yearly becoming both scarcer and poorer in quality. In the United States, apart from the Southern States and the northern portion of New York State, there are practically no ores available for the manufacture of pig iron suitable for the basic Bessemer process. The acid Bessemer process therefore reigns supreme, and there is a strong

rivalry between this process and the open-hearth. In Germany the basic Bessemer process takes the lead over other processes, but nearly 3,500,000 tons were made by the open-hearth process.

The Bessemer process, which is perhaps the cheapest, requires a special quality of pig iron and this quality is tending to become dearer. The waste of metal in the Bessemer process must of necessity always be higher than in any form of open-hearth process. This fact accentuates the importance of the question of the cost of pig iron. The higher the price the greater the cost due to waste. There can be no doubt that the transfer of the Hill ore lands to the steel corporation must tend in the long run to increase permanently the price for pig iron in the United States, and as the margin for economies in the Bessemer process is less than that of the basic open-hearth process, when pig iron becomes too high, the latter process will undoubtedly come more in the foreground. In regard to steel rails this will be quite significant. The 100-pound per yard rail in the United States does not give the satisfaction which the lighter section rail does, as the breakage has proven to be more serious since greater duty has been demanded, following the use of heavier rolling stock and increased tonnage carried. The basic open-hearth process with its higher carbon and lower phosphorus gives a rail greater reliability and better wearing qualities. In the course of the next two years rail plants in the United States will be able to turn out large quantities of basic open-hearth rails in excess of what they are doing already. Canada is at present making open-hearth rails for her own use. England has already two rail mills making use of this process, and probably Germany will soon also adopt it for rails.

It appears, therefore, that unless large deposits of pure ore are found, and are continually developed to keep pace with the increased consumption of iron all over the world, the cost of Bessemer iron will go up, and the manufacture of rails by necessity will pass back again to the open-hearth process. It will seem strange, when this actually comes to pass, that steel rails, which were first made by the open-hearth process, should again be produced in this way after the original process had so long been ousted by the Bessemer process.

THE USE OF KEROSENE OIL IN ENGINES BUILT FOR GASOLINE.

H. B. Maxwell in *International Marine Engineering*, December, 1906.

The constantly increasing demand for gasoline, owing to new fields for its use being rapidly developed, has caused a steady increase in price, which makes the use of the heavier

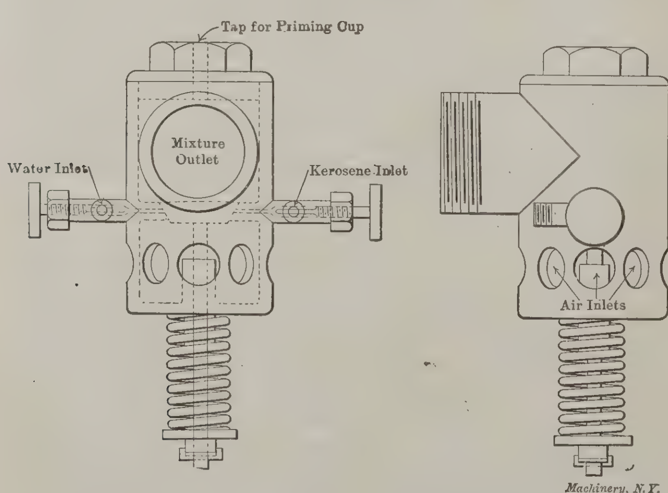


Fig. 1. Mixing Valve for Kerosene Oil used in Gasoline Engines.

and cheaper liquid hydrocarbon fuels a matter of such importance that it has for some time past attracted the attention of engineers engaged in designing internal combustion engines. Kerosene can be used in many engines after being warmed up on gasoline, but not economically unless some device is added to insure perfect combustion of the fuel or to aid in the better vaporization of the fuel before it reaches the combustion chamber. It has been found that by using a common mixing valve of the type shown in Fig. 1, kerosene can be used successfully.

Referring to Fig. 1, it will be noticed that the nut forming the cap to the body of the valve is tapped for a priming cup. This is to be filled with gasoline, and the engine started on this. As soon as the engine is heated up a little, the needle valve controlling the kerosene inlet is opened. After doing this a blue smoke will be noticed at the exhaust pipe. The

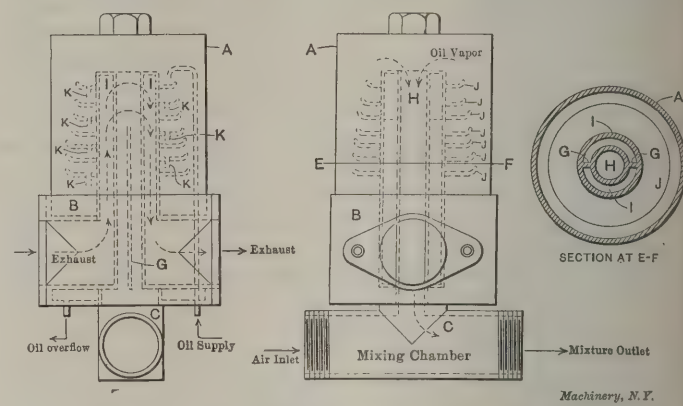


Fig. 2. Kerosene Oil Vaporizer used in Gasoline Engines.

valve controlling the water supply is then turned on, a little at a time, until this smoke clears away. This valve will work on most four-cycle engines using high compression.

Fig. 2 shows an exhaust heated vaporizer that can be used with any engine. It consists of a body *B* and *C*, cast integral with the pipes and oil pans, as shown by the dotted lines and in the section. The cap *A* screws into the body *B*, and can be readily removed to clean the pans of any tar or coke deposited from the fuel used. The oil supply may be operated by a variable stroke pump controlled by a governor, or the engine can be controlled by throttling the mixture between the vaporizer and the intake valve. There must be an air regulator attached to the mixture chamber *C* at the end opposite from the end used to convey the mixture to the engine.

The exhaust enters the T-shaped pipe *I I* and impinges against the pipe *H* and the guides *G G*, giving the exhaust

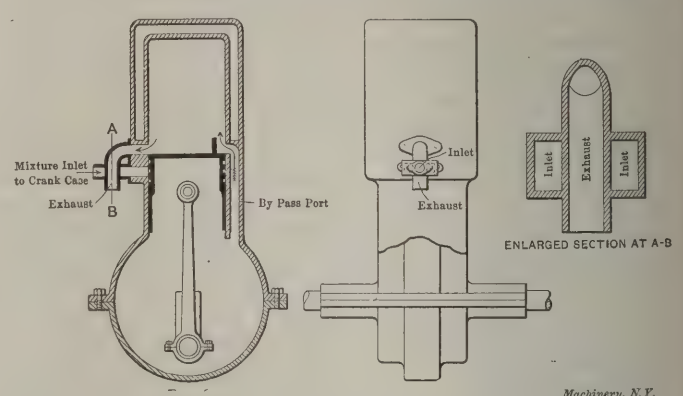


Fig. 3. Kerosene Oil Vaporizer.

gases the course shown by dotted arrows in the view to the left. This imparts part of the heat of the exhaust gases to the walls of the pipe *I I* and the pans *J J*. It will be noticed that the overflow pipes *K K* from each pan to the one next below it, bring the fuel not vaporized by the first hot surface into contact with other hot pans, to complete the vaporization. The oil, gas or vapor flows down pipe *H* to the chamber *C*, where it is mixed with the proper amount of air to furnish the correct mixture.

Fig. 3 shows a device in which the exhaust and intake pipes are cast integral. The inlet from carbureter at the left opens directly against the hot walls of the exhaust pipe, and, as shown in the small sectional view, divides and passes around the exhaust pipe and enters the port to the crank case. To start a two-cycle engine with this device, it must be primed with gasoline, the priming cup being located on top of the cylinder; or the combination exhaust and inlet pipe could be heated with a torch.

ON THE ART OF CUTTING METALS.—5.*

FRED. W. TAYLOR.

FORGING AND GRINDING TOOLS (Continued).

Undoubtedly one of the most economical shapes for tools, when both dressing and grinding costs are considered, is that shown in our standard tools, Figs. 16 to 21 (March issue).

In examining these tools it will be noted that in the 1-inch tool (Fig. 44), for instance, the cutting edge is 1 3/16 inch above the top of the body, and if we assume that 3/64 of an inch of metal ground off from the height of the tool will be sufficient to sharpen the cutting edge on an average, it is evident that a tool of this shape can be ground 24 times before the corner of the emery wheel begins to cut into the body of the tool. If after this we continue to grind the tool, there will still remain as many grindings on this tool as upon the tool, Fig. 26 (March issue), before the wheel shall have ground down into the body of the tool for a sufficient depth to weaken it. Thus it is clear that our standard tool has a shape which permits it to be reground from three to five times as often as the ordinary shape.

The Best Method of Forging a Tool is to Bend or Turn Up its End.

In dressing these tools the end of the piece of steel to be made into the tool is bent or turned up by sledging it down across the corner of the anvil. Figs. 31 to 42, inclusive, illustrate one method of doing this work. It is of interest to note that after the steel from which the tool is made has been cut to the required length and properly marked for identification, these tools up to and including tool steel of 1 inch x 1½ inch can be completely dressed by a good smith and his helper ready for grinding in two heats, provided a small steam hammer with plain flat dies is available for striking the tool a few blows at the proper time; also that without a steam hammer, each tool can be readily dressed with three heats by a smith and one helper or in two heats by a smith and two helpers, the two helpers being required for only a part of a minute.

Bad Practice to Nick the Bar or Tool Steel and Break it off Cold.

The practice of nicking the bar of tool steel with a cold chisel at points corresponding to the proper length of the tool, and then breaking it where nicked by a blow of the sledge on the anvil, is on the whole unwise, as not unfrequently almost invisible cracks are started which may only fully develop after the tool is in use. In cutting to length with a "hot chisel" a low heat is sufficient and the same heat can be used for stamping the rear end of the tool for identification. The following are the steps to be taken in forging the tool after it has been cut to length from the bar.

Heating the Tool.

A. Heat the tool rather slowly so as to insure uniform heating to the center of the bar, turning it over several times while in the blacksmith's fire. The proper heat with the modern low carbon, high tungsten and chromium steels is as high a heat as can be used without causing the steel to disintegrate or fly to pieces when struck with the sledge. Contrary to all former laws and traditions in heating tool steel, this type of steel is not injured by heating beyond a cherry red in dressing, provided the tool is finally heated to the high melting point according to the Taylor-White process. The proper dressing heat varies according to the chemical composition of the tool steel, but is in most cases from a yellow to a light yellow heat corresponding to a temperature of 1800 degrees F. to 1900 degrees F.

In the case of a tool 1 inch in the body, this yellow heat should extend 5½ inches back from its point, and in the following description the dimensions given will be understood to refer to a tool of this size.

When several tools of the same shape are to be dressed at the same time, it is best to heat them slowly in lots of, say, four to six tools at a time; the part of the tools to be heated is brought closer and closer to the hot portion of the fire as they are gradually warmed up, while the one particular tool which is to be forged next is kept directly over the hottest part. A clear coke fire, made and kept sufficiently deep to measurably prevent the blast from coming directly in contact with the tool is, on the whole, preferable to the ordinary soft coal fire used by blacksmiths. This is only true, however, because it is, on the whole, easier to get a uniform fire with coke as the fuel than when coal is used in a blacksmith's fire. Experiments have shown clearly that if sufficient care is used, a first-class soft coal fire oxidizes, and therefore injures the tools less than a first-class coke fire.

Bending or Turning Up the Nose of the Tool.

B. Clamp the tool down hard on the top of the anvil, as shown in Fig. 31, by drawing down the clamp *C* by means of the wedge *W*, the upper edge of which presses against the

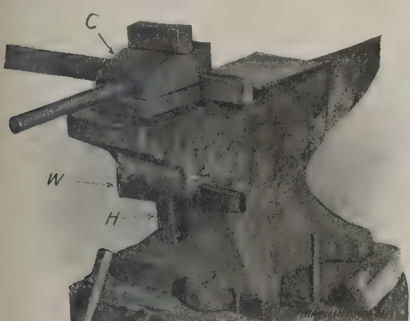


Fig. 31. Tool Cut Off and Clamped to Anvil ready to be Bent Down.

Fig. 32. Cutting Roughly to Proper Lip Angle.

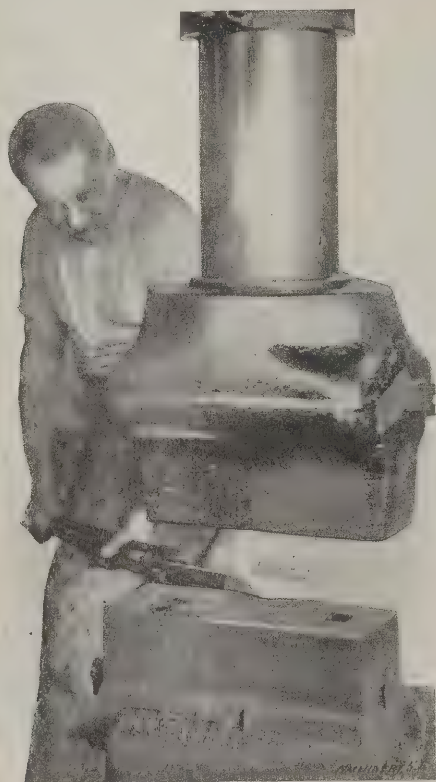


Fig. 33. Heel of Tool being Drawn Down under Steam Hammer.

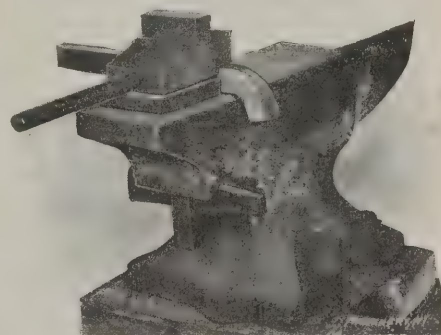


Fig. 34. Tool Bent Down across Edge of Anvil.

Fig. 35. Cutting Front Corners off the Nose.

* Abstract of paper presented before the American Society of Mechanical Engineers, December, 1906.

lower side of the anvil, and the lower edge against the end of the slot made in the shank of the clamp *C*, which passes down through a square hole in the anvil and projects below the underside of the same. The tool is clamped so that 2⅜ inches of its end project beyond the edge of the anvil.

C. The blacksmith and his helper, each working with a sledge, bend the heated end of the tool down into the position shown in Fig. 34. (The exact shape of tool as thus bent over is shown in Fig. 37.)

A gage similar to that shown in Fig. 36, should be mounted close to the blacksmith's anvil, so that he can readily test the bending of the tool to secure the proper clearance angle. This

Fig. 36. Trying Tool against Cone Gage.

gage consists of a small surface plate with a hole drilled near one corner, into which are fitted a series of cones turned to different angles, corresponding to the various shapes into which the tools are to be bent. The tool without removing the tongs is placed with its bottom surface on the surface plate and the clearance surface against the tapered cone, where at a glance the blacksmith can see whether he has bent it to the correct angle. A similar clearance gage should also be mounted close to the tool grinder so that the clearance angle called for in grinding can be quickly and accurately measured by the operator.

Drawing Down the Heel of the Tool to Secure Good Bearing.

D. The wedge *W* of clamp *C* is then loosened with a hammer, and the tool quickly removed to the steam hammer with flat dies, where the curved portion at the heel of the tool is placed, as shown in Fig. 33, upon the edge of the die, and drawn down with a few blows of the hammer so as to flatten it into a wedge shape. This flattening spreads the metal out laterally until what was a rounding corner becomes almost a right angle; thus extending the flat surface of the bottom of the tool further forward, so as to furnish a support almost under the cutting edge. (The tool in this condition is shown in Fig. 38.)

In case no small steam hammer is available, the heel of the tool is flattened in a similar manner by sledging upon the blacksmith's anvil.

Cutting Off Corners of Nose of Tool so as to Save Work in Grinding.

E. The tool is placed upon the edge of the anvil, as shown in Fig. 35, and its two corners are cut off with a chisel so as to make its nose approximate to the proper curve. The bottom of the heel of the tool is also trimmed off, if necessary, so as to make it flush with the bottom of the tool. The height is then marked with soapstone or a nick of the chisel upon the nose of the tool for cutting to the proper lip angle, and the tool is returned to the fire for its second heat.

It should be noted that operations *B*, *C*, *D* and *E* are all done with a single heat. If, however, at any stage in the process, through lack of skill or unusual delay, the tool is cooled to below a light cherry red, corresponding to a heat of 1550 degrees F., no further forging should be done without reheating.

Cutting to Correct Height and Lip Angle.

F. After slowly and thoroughly reheating the tool, the upper portion of the nose is cut, as shown in Fig. 32, to the proper lip angle, care being taken to secure both the correct angle and height called for. The use of a specially designed hot chisel or set, as shown in this cut will help the blacksmith in this operation.

Bending or Setting the Nose of the Tool over to one Side and Truing Up the Whole Tool.

G. The whole nose of the tool is then bent and set over sidewise, through the use of a flatter, as shown in Fig. 42.

H. The tool should be carefully straightened on the anvil so as to have as nearly as possible a true bearing upon its bottom surface. This bearing should extend all the way from the front to at least half-way back on the tool. A surface plate should be provided close to the blacksmith's anvil for testing the accuracy of this operation. The importance of having this bottom surface true is not ordinarily appreciated. The tool should bear at all points along its bottom surface, at its forward end, directly underneath the cutting edge, in order to avoid chatter or breaking through too much overhang, and directly beneath the clamp to avoid either bending or breaking at this point.

Fire or Heat Cracks in Tools come from Four Principal Causes.

A. The first cause is seams or internal cracks in the bar, caused mainly by imperfections in the ingot or by too rapid or uneven heating in hammering the bar. Blacksmiths are prone to attribute all cracks in their tools to the maker of the tool steel. It is our observation, however, that nine-tenths of the cracks in tools are due to bad treatment in the smith shop rather than to imperfections in the bar.

B. The second cause for cracking is breaking the bar while cold, as referred to above.

C. The third cause is heating the bar unevenly by keeping it in the same position in the fire throughout the time of heating. The portion of the tool next to the fire expands more rapidly than the steel directly above it, and actually tears the colder metal apart.

D. The fourth cause for cracks is too rapid heating in an intense fire. Even if properly turned over and over, the outside portions of a tool (particularly if it be of large body) are heated to a high forging heat before the center of the section has reached its proper temperature. If hammered when in this condition, internal cracks in the tool are likely

Figs. 37, 38 and 39. Figs. 40, 41 and 42.

Successive Stages of Forged and Ground Tools.

to be developed, because the center of the bar, instead of being malleable as the outside is, still remains comparatively cold and brittle, and the steel being unable to flow is torn apart, thus producing internal cracks. Internal cracks are also caused in some cases by hammering the outside of the bar with too light taps of the hammer. The force of the hammer blow should be powerful enough to penetrate to the center of the bar and should, therefore, increase with the size of the steel.

It is from the third and fourth causes (*C* and *D*) that cracks are most frequently developed and, therefore, slow heating and frequent turning of the bar in the fire are to be recommended, particularly during the early stages of heating. If

the heat must be hurried, let it be during the final rise in temperature from the cherry red, say, up to the proper forging heat.

The above remarks refer of course to high-speed tools, not to either tempered tools or the old self-hardening tools which should not be heated beyond a light cherry red in forging.

Relative Work to be Done in the Smith Shop and on the Grinding Machine for Maximum Economy in Making Tools.

It requires much and careful observation, made not in a desultory manner but with a stop-watch, to determine the exact degree of accuracy with which the shape of the nose of the tool should be forged; in other words, to determine how much of the work of shaping the nose of the tool should be done by the smith and how much should be left for the grinder. It is evident that this will depend upon the method and the facilities in the machine shop for rapid and accurate grinding. If the grinding is done by hand, and on a grindstone or on a fine emery wheel, it will take a far longer time and be much more expensive than if done on an automatic grinding machine which is supplied with a corundum wheel, the size of the grit of which is carefully selected, so as to grind with the greatest rapidity while at the same time leaving a sufficiently smooth finish. The better and more rapid the grinding facilities then, the smaller should be the percentage of work done in shaping the tool in the smith shop, and the larger the percentage done by the grinder, and *vice versa.*

Limit Gage for Dressing Tools.

In Fig. 43 is shown a gage giving the forging limits which have been demonstrated to be most economical in forging a tool of the size shown in Fig. 44, in shops in which first-class automatic tool grinders are used. In shops in which tools are ground by hand on an emery wheel or grindstone, it will be found economical for the smith to shape the curve of the cutting edge of the tool within much closer limits than those given in this gage.

This limit gage is placed with its parallel shank on top of the body of the tool, while the curved slot is directly over the curved nose of the cutting edge, hence in dressing the tool, and in approximating the curve of the cutting edge, all that is required of the smith is that every portion of the outline of the cutting edge of the tool shall come within the limits of the curved slot. On looking down through the slot in the gage, the smith should see the whole outline of the cutting edge of the tool, and, provided the whole line of the cutting edge as left by the smith is in sight through this slot, it is of no consequence whether the curve is irregular and jagged in shape or whether it is left smooth. It will be cheaper for the grinder to grind off the irregularities in the curve than for the smith to take the extra time required for this purpose. Each type of tool used in the machine shop should be carefully studied in this way so as to establish the most economical limits within which the smith is to do his work, and limit gages similar to the one illustrated, should in all cases be carefully made. The writer wishes to emphasize again the desirability of so designing tools and, particularly, of so adjusting the relative amount of work to be done by the grinder and the smith, that all sizes up to 1 x 1½ inch may be dressed in two heats, and still leave as little work as practicable for the grinder.

Importance of Using a Heavy Stream of Water Directly on Nose of Tool in Grinding Tools.

Attention has already been called to the great injury which is constantly being done to the modern high-speed tools by heating the cutting edge too hot on the grindstone. It becomes of the first importance in grinding, whether an automatic tool grinder is used or whether tools are ground by hand, always to throw a heavy stream of water upon the nose directly at the spot where the emery wheel or grindstone is doing its work. The practice of pouring water upon the emery wheel above the tool and allowing the stone to carry the water along with it is to be avoided, as this method provides entirely too small an amount of water to properly cool the tool. We have found by experiment that it requires a stream of water of not less than five gallons per minute, thrown directly upon the cutting edge of the tool, to prevent its being overheated on the grindstone. Even then, the man running the grinder should be under frequent supervision, or the temptation to force the grinding, to hurry his work and thus to overheat the tool, may prove too great. The water should be thrown in a large stream with slow velocity to avoid splashing.

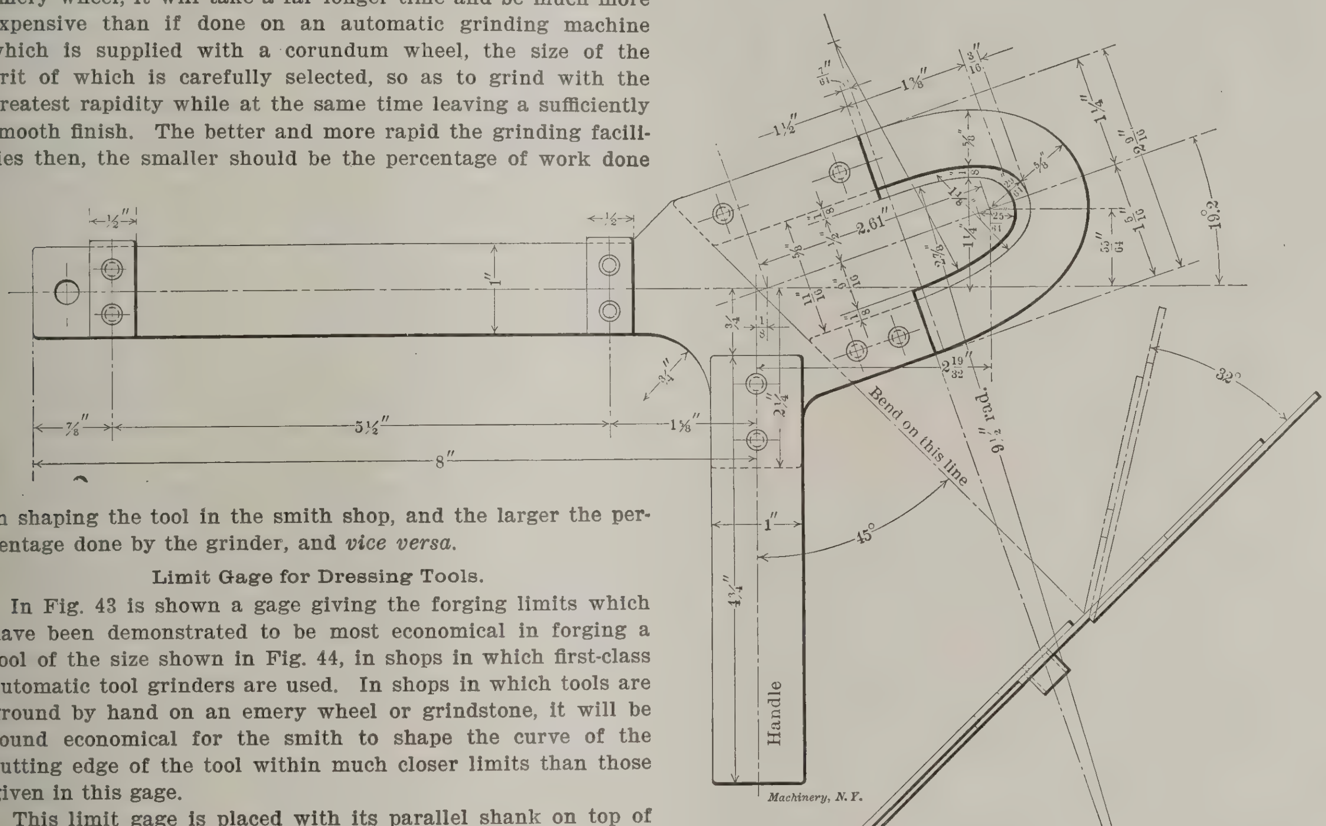


Fig. 43 Limit Gage for Forging 1-inch Round Nose Roughing Tool.

The necessity for not overheating the tool in grinding also modifies the shape for forging our standard tool. The noses of our standard tools, shown in Figs. 41 and 42, have clearance angles of 20 degrees as they come from the smith shop, whereas a clearance angle of 6 degrees is ample for shop use. In other words, the noses of our standard tools lean far forward out of the perpendicular. The object of this is to make the distance beneath the cutting edge, which must be ground off of the flank each time the tool is sharpened as short as possible. In this way a smaller pressure between the tool and the grindstone is called for, the tool is ground in a much shorter time, less heat is generated by the grindstone, and there is less danger of injuring the tool from overheating.

The nose when cut off by the blacksmith has a much more acute lip angle than is actually needed in the machine shop for cutting. This acute angle is given the tool for the same reason as was the extra clearance angle, namely, to diminish the extent of the surface which must be ground from the lip surface of the tool. The diminution in the grinding which results from leaning the nose of the tool forward and cutting a much steeper side slope in the smith shop becomes apparent from a comparison with the view of a tool dressed and ground in the ordinary way, as shown in Figs. 24, 26 and 27 (March issue).

In Figs. 16 to 21 (March issue) it will be noted in each

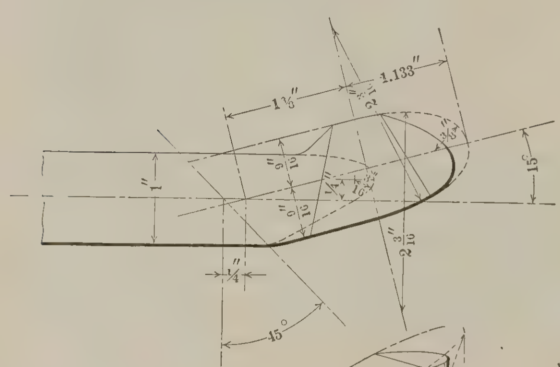
case that broken lines above and beyond the upper part of the nose of the tool indicate the shape to which the tool is forged, while the solid, heavy lines indicate the shape to which the tool is ground at its first grinding.

Our reason for leaving so much metal in the forged tool to be ground off is that sometimes in giving the tool the high heat, owing to too slow a fire being used, the metal close to the surface of the nose of the tool is somewhat injured, and by grinding off this exposed point of the tool at its first grinding, a tool which runs at once at its highest cutting speed can be obtained.

Tools with Keen Lip Angles much more Expensive to Grind than those with Blunt Lip Angles.

While on the subject of grinding, it should be pointed out that the steeper the side slope of the lip surface, the larger becomes the area of the surface which must be ground, and the smaller the number of times a tool of a given height can be ground before redressing. A steep side slope also renders the cutting edge more likely to be overheated in grinding as it leaves a smaller cross section of metal in the wedge-shaped section close to the cutting edge for carrying away the heat.

If economy of grinding alone then were to be considered, a



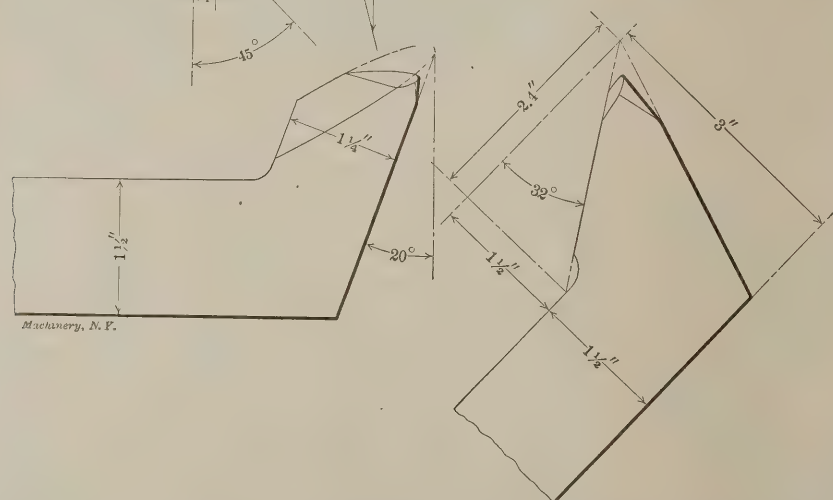


Fig. 44. Detailed Dimensions of 1-inch Round Nose Roughing Tool. Forged Outline shown by Dotted Lines and Ground Form by Full Lines. Clearance, 6 degrees; Back slope, 8 degrees, and Side Slope 14 degrees.

steep side slope in the tool would be avoided for every reason. A consideration of the above facts will also make it more clear why all machinists who grind their own tools incline toward too little rather than too much side slope.

Flat Surfaces Tend to Heat the Tools in Grinding.

Flat surfaces coming into contact with the emery wheel also tend very greatly to heat the tool, chiefly because the surface which is being worked upon is soon ground so as to fit so exactly and closely against the outside surface of the grindstone that no water can find its way between the stone and the tool and thus cool the latter. It is for the purpose of giving the water free access to the face of the tool being ground that in grinding tools by hand the best grinders invariably keep the tool more or less wobbling about upon the face of the grindstone while the greater part of the metal is being roughed off. For the same reason they hold the tool stationary against the stone only during the last stage of the grinding when finishing the lip surface to the exact angle required. In selecting an automatic grinder, no machine should be purchased which does not permit free access of the water to the flat surface of the tool during the operation of grinding.

It is for a similar reason also that tools with a curved cutting edge are to be preferred from the standpoint of grinding to those with a straight line on the cutting edge. The straight line always implies a flat clearance surface beneath the cutting edge for grinding, and a flat surface is far more difficult to grind without heating than a curved surface.

The Selection of the Emery Wheel.

The selection of the proper emery wheel for tool grinding is also a matter of great importance. The hardest grit obtainable should be used, and for grinding ordinary shop tools, so far as we know, corundum is the best. Rapid grinding is promoted by the use of a coarse grit in the wheel. On the other hand, too coarse grit leaves an irregular outline at the cutting edge of the tool. After experimenting with emery wheels varying greatly in their coarseness, we have adopted as our standard an emery wheel having a mixture of grits known as size No. 24 and size No. 30. A corundum wheel made of these two sizes of grit grinds fast and leaves a sufficiently smooth finish on the tool.

Desirable Features in an Automatic Tool Grinding Machine.

Tools should never be ground by fastening them solidly in a slide or tool rest which is fed directly against the emery wheel with a screw; since soon after the grinding starts, the surface of the tool is made to fit exactly against the surface of the stone, after which grinding is exceedingly slow and the tool is rapidly overheated. It may almost be said that the moment a tool becomes a close fit against the side of the grindstone, grinding ceases and heating begins.

Much more rapid grinding can be done upon a grinding machine in which there is provided a means for automatically adjusting the pressure of the tool against the emery wheel. Each sized tool should have adapted to it a pressure which is automatic and which is just sufficient to grind rapidly without danger of overheating. An automatic machine of this type will do about twice the work of a machine in which the pressure between the tool and the emery wheel is regulated according to the judgment of the grinder.

Desirability of a Large Supply of Tools, a Complete Tool Room, and an Automatic Grinding Machine, even in a Small Shop.

We have pointed out that the greatest gain from a study of the art of cutting metals can be attained only through reorganizing the system of management of the shop in such a way that it is possible to assign daily tasks to the workmen, and that in preparing for this a thorough system must be established for delivering to each workman an ample supply of tools ground to standard shapes ready for use. This involves a tool room with ample storage space for a large number of extra tools. For economy, even in a small shop, the tools should be ground in lots or batches, *i. e.*, there should be such an ample supply of tools in the shop that dull tools of a given size and shape can be allowed to accumulate until a lot, say, ten to twenty or more, is ready for the grinder. With this system it is economical for the small shop as well as the large one to use an automatic tool grinder.

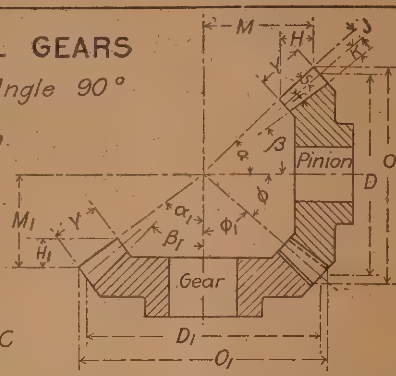
In our experience in reorganizing the management of machine shops we almost invariably have difficulty in persuading the owners to maintain the large supply of tools which is needed to get the full benefit from the task system. It seems desirable, therefore, to lay particular stress upon all of the elements connected with the tool supply—of which accurate and rapid grinding without injuring the tool is the most important. There is little if any economy in the use of an automatic tool grinding machine unless standard shapes for all tools have been adopted, and unless a large supply of tools is kept in a well-equipped tool room, from which they are issued to the men, no workman being allowed to grind his own tools.

BEVEL GEAR FORMULAS.—I.

BEVEL GEARS

Shaft Angle 90°

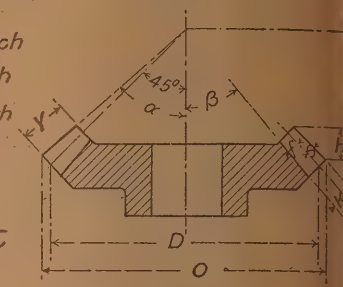
P = Diametral Pitch
C = Circular Pitch
N = Number of Teeth
$\pi = 3.1416$
$J = \frac{1}{P}$ or $.3183\,C$
$K = \frac{1.157}{P}$ or $.3683\,C$



PINION		GEAR	
N	$D \times P$ or $\frac{D \times \pi}{C}$	N_1	$D_1 \times P$ or $\frac{D_1 \times \pi}{C}$
D	$\frac{N}{P}$ or $.3183\,CN$	D_1	$\frac{N_1}{P}$ or $.3183\,CN_1$
O	$D + \frac{2\cos\phi}{P}$ or $D + (.6366\,C \times \cos\phi)$	O_1	$D_1 + \frac{2\sin\phi}{P}$ or $D_1 + (.6366\,C \times \sin\phi)$
ϕ	$\operatorname{Tan}\phi = \frac{N}{N_1}$	ϕ_1	$90 - \phi$
$\operatorname{Tan} S = \frac{2\sin\phi}{N}$,		$\operatorname{Tan} f = \frac{2.314\sin\phi}{N}$	
α	$\phi + s$	α_1	$\phi_1 + s$
β	$\phi - f$	β_1	$\phi_1 - f$
M	$\frac{O_1}{2} - \frac{2\sin\phi}{P}$ or $\frac{O_1}{2} - (.6366\,C \times \sin\phi)$ or $\frac{O}{2} \times \cot\alpha$	M_1	$\frac{O}{2} - \frac{2\cos\phi}{P}$ or $\frac{O}{2} - (.6366\,C \times \cos\phi)$ or $\frac{O_1}{2} \times \cot\alpha_1$
H	$Y \times \cos\alpha$	H_1	$Y \times \cos\alpha_1$
Number of Teeth for which to select Cutter			
$\frac{N}{\cos\phi}$		$\frac{N_1}{\sin\phi}$	

MITER GEARS

P = Diametral Pitch
C = Circular Pitch
N = Number of Teeth
$\pi = 3.1416$
$J = \frac{1}{P}$ or $.3183\,C$
$K = \frac{1.157}{P}$ or $.3683\,C$



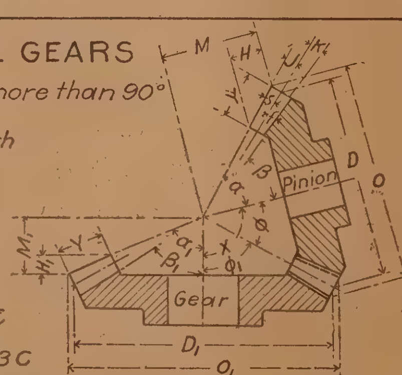
N	$D \times P$ or $\frac{D \times \pi}{C}$
D	$\frac{N}{P}$ or $\frac{C \times N}{\pi} = .3183\,CN$
O	$D + \frac{1.4142}{P}$ or $D + .45\,C$
$\operatorname{Tan} s = \frac{1.4142}{N}$, $\operatorname{Tan} f = \frac{1.6362}{N}$	
α	$45° + s$
β	$45° - f$
M	$\frac{O}{2} - \frac{1.4142}{P}$ or $\frac{O}{2} - .45\,C$
H	$Y \times \cos\alpha$
Number of Teeth for which to select Cutter	
$\frac{N}{.7071} = N \times 1.4142$	

BEVEL GEAR FORMULAS.—II.

BEVEL GEARS

Shaft Angle more than 90°

P = Diametral Pitch
C = Circular Pitch
N = Number of Teeth
x = Shaft Angle
$\pi = 3.1416$
$J = \frac{1}{P}$ or $.3183\,C$
$K = \frac{1.157}{P}$ or $.3683\,C$

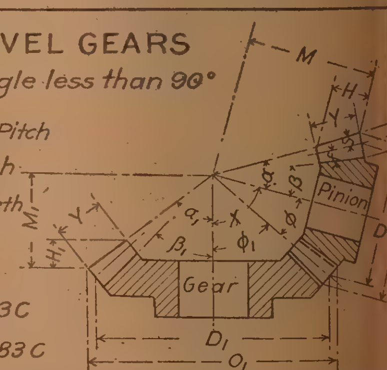


PINION		GEAR	
N	$D \times P$ or $\frac{D \times \pi}{C}$	N_1	$D_1 \times P$ or $\frac{D_1 \times \pi}{C}$
D	$\frac{N}{P}$ or $.3183\,CN$	D_1	$\frac{N_1}{P}$ or $.3183\,CN_1$
O	$D + \frac{2\cos\phi}{P}$ or $D + (.6366\,C \times \cos\phi)$	O_1	$D_1 + \frac{2\cos\phi_1}{P}$ or $D_1 + (.6366\,C \times \cos\phi_1)$
ϕ	$\operatorname{Tan}\phi = \frac{\cos(x - 90°)}{\frac{N_1}{N} - \sin(x - 90)}$	ϕ_1	$x - \phi$
$\operatorname{Tan} S = \frac{2\sin\phi}{N}$,		$\operatorname{Tan} f = \frac{2.314\sin\phi}{N}$	
α	$\phi + s$	α_1	$\phi_1 + s$
β	$\phi - f$	β_1	$\phi_1 - f$
M	$\frac{O}{2} \times \cot\alpha$	M_1	$\frac{O_1}{2} \times \cot\alpha_1$
H	$Y \times \cos\alpha$	H_1	$Y \times \cos\alpha_1$
Number of Teeth for which to select Cutter			
$\frac{N}{\cos\phi}$		$\frac{N_1}{\cos\phi_1}$	

BEVEL GEARS

Shaft Angle less than 90°

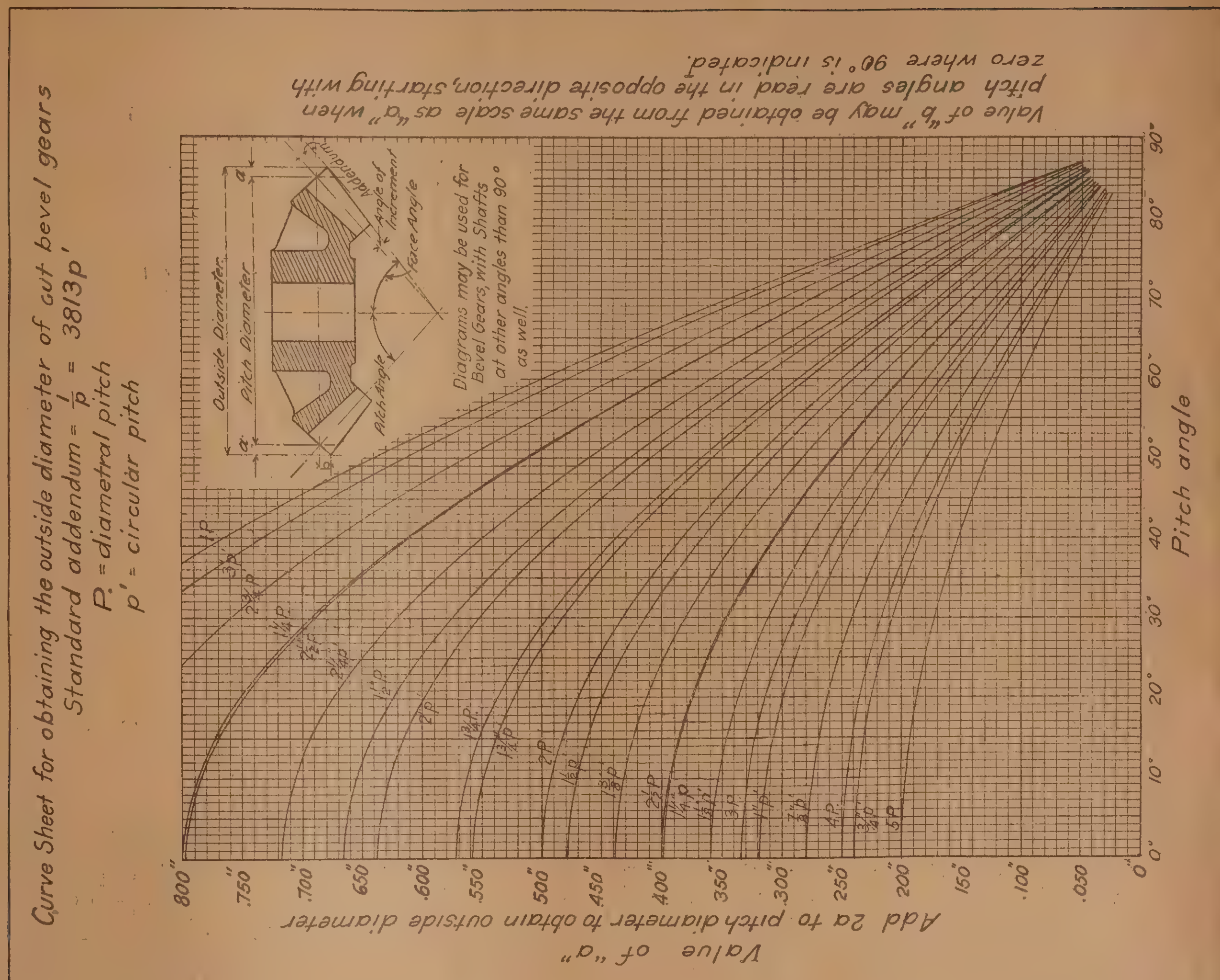
P = Diametral Pitch
C = Circular Pitch
N = Number of Teeth
x = Shaft Angle
$\pi = 3.1416$
$J = \frac{1}{P}$ or $.3183\,C$
$K = \frac{1.157}{P}$ or $.3683\,C$



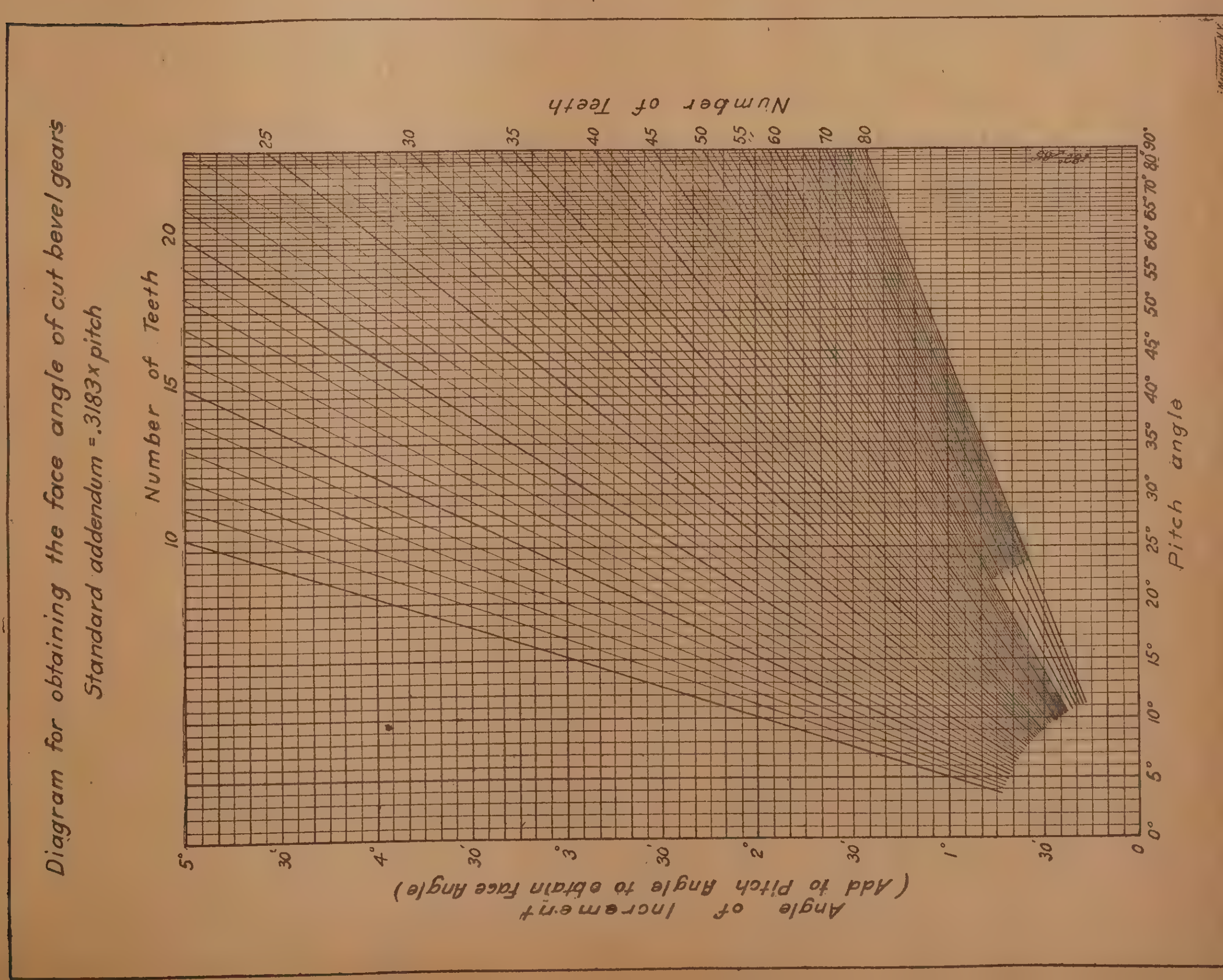
PINION		GEAR	
N	$D \times P$ or $\frac{D \times \pi}{C}$	N_1	$D_1 \times P$ or $\frac{D_1 \times \pi}{C}$
D	$\frac{N}{P}$ or $.3183\,CN$	D_1	$\frac{N_1}{P}$ or $.3183\,C$
O	$D + \frac{2\cos\phi}{P}$ or $D + (.6366\,C \times \cos\phi)$	O_1	$D_1 + \frac{2\cos\phi_1}{P}$ or $D_1 + (.6366\,C \times$
ϕ	$\operatorname{Tan}\phi = \frac{\sin x}{\frac{N_1}{N} + \cos x}$	ϕ_1	$x - \phi$
$\operatorname{Tan} S = \frac{2\sin\phi}{N}$,		$\operatorname{Tan} f = \frac{2.314\sin\phi}{N}$	
α	$\phi + s$	α_1	$\phi_1 + s$
β	$\phi - f$	β_1	$\phi_1 - f$
M	$\frac{O}{2} \times \cot\alpha$	M_1	$\frac{O_1}{2} \times \cot\alpha_1$
H	$Y \times \cos\alpha$	H_1	$Y \times \cos\alpha_1$
Number of Teeth for which to select Cutter			
$\frac{N}{\cos\phi}$		$\frac{N_1}{\cos\phi_1}$	

"Bevel Gear Formulas" and "Bevel Gear Diagrams."

BEVEL GEAR DIAGRAMS.—I.



BEVEL GEAR DIAGRAMS.—II.



BEVEL GEAR DIAGRAMS.

GEO. S. HOELL.

In preparing shop drawings of bevel gears with planed teeth, a comparatively large amount of figuring has to be done, modern practice demanding greater accuracy than can be obtained even by carefully laying out the gear full size. Those drawing rooms in which gear design is of daily occurrence, are usually equipped with extensive tables, as well for pitch diameters as for pitch angles of bevel gears. As far as my experience goes, these two data are most conveniently recorded in a tabular form, as is the usual practice. But a few other data are necessary for dimensioning the gear, such as the angle of increment, the outside diameter, and the projection of the extreme edge of the teeth beyond the pitch circle.

Brown & Sharpe, in one of their books on gear dimensions, have a table giving the Angle of Face, this being the complement of the face angle indicated by the cut in the supplement. The trouble with tables is that they are voluminous and liable to errors, and, in this particular case, that some of the angles repeat themselves several times. Other books give very extensive tables for the outside diameters, all calculated for 1 diametral pitch, the outside diameter in other cases to be found by dividing the tabular dimension by the diametrical pitch of the gear under consideration, the latter operation being very cumbersome when an even circular pitch is being used. The dimension b in the cut is sometimes tabulated in a similar way. The accompanying diagrams (see Supplement) contain, in a very concentrated and convenient shape, all the data just mentioned.

The best way of explaining the diagrams is to take an example, such for instance, as the following: Find the outside diameter, face angle, and backing b of a bevel gear with 40 teeth, whose pitch angle is 56° 59′, 2 diametral pitch, 20 inches pitch diameter. Referring to the curve sheet for values of a, follow a line close to the 57-degree pitch angle line, until it intersects the curve for $2P$. Follow this point horizontally to the left, and we find that a equals 0.272 inch. The outside diameter will be the sum of the pitch diameter, 20, and $2a$, or 20.54 inches. Dimension b may be found from the same sheet in the same manner, excepting that the pitch angles must be read in the opposite direction. Thus we have to read off 56° 59′, where 33° 1′ is indicated, and, in the same way as above described, we find that b equals 0.417 inch, the last figure being estimated. Following the corresponding line for 56° 59′ on the other diagram, to the intersecting point with the line indicated by 40 (teeth), and radiating from zero, we find by transferring this point over to the scale for the angles of increment, that the latter in this case equals 2° 23′, the units of the minutes being estimated. This angle added to the pitch angle of 56° 59′, gives a face angle of 59° 22′.

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BEVEL GEAR FORMULAS.

HERMAN ISLER.

Much has been written about miter and bevel gears, and a number of methods have been proposed by different designers for the solution of the problems involved. From these different articles I have compiled a systematic set of formulas (see Supplement) both for diametral and circular pitches. The formulas are very simple; it is necessary, however, that the draftsman be able to read the tables of trigonometrical functions. The following examples have first been solved graphically, by laying them out full size, and then have afterwards been compared with the figures obtained by the formulas given in these tables.

Example 1. Miter Gears.

Given: Pitch diameter $D = 5$ inches, diam. pitch $P = 6$, face $Y = 1\frac{1}{4}$ inch.

Number of teeth $N = D \times P = 5 \times 6 = 30$

$$\text{Outside diameter } O = D + \frac{1.4142}{P} = 5 + \frac{1.4142}{6} = 5.236 \text{ inches.}$$

$$\text{Tan } s = \frac{1.4142}{N} = \frac{1.4142}{30} = 0.04714,\ s = 2°\ 42'$$

$$\text{Tan } f = \frac{1.6362}{N} = \frac{1.6362}{30} = 0.05454,\ f = 3°\ 7'$$

Turning angle $\alpha = 45° + s = 45° + 2°\ 42' = 47°\ 42'$

Cutting angle $\beta = 45° - f = 45° - 3°\ 7' = 41°\ 53'$

$$\text{Distance } M = \frac{O}{2} - \frac{1.4142}{P} = 2.618 - 0.236 = 2.382 \text{ ins.}$$

Distance $H = Y \times \cos\alpha = 1\frac{1}{4} \times 0.67301 = 0.841$ inch.

If the gears are cut, use the following formula to find number of teeth, for which to select cutter: $N \times 1.4142 = 30 \times 1.4142 = 42$ teeth.

Example 2. Miter Gears.

Given: No. teeth $N = 25$, circular pitch $C = \frac{1}{2}$ inch, face $Y = \frac{7}{8}$ inch.

Pitch diameter $D = 0.3183\ C\ N = 0.3183 \times 0.5 \times 25 = 3.979$ ins.

Outside diameter $O = D + 0.45\ C = 3.979 + (0.45 \times 0.5) = 3.979 + 0.225 = 4.204$ inches

$$\text{Tan } s = \frac{1.4142}{N} = \frac{1.4142}{25} = 0.05657,\ s = 3°\ 14'$$

$$\text{Tan } f = \frac{1.6362}{N} = \frac{1.6362}{25} = 0.06545,\ f = 3°\ 45'$$

Turning angle $\alpha = 45° + s = 45° + 3°\ 14' = 48°\ 14'$

Cutting angle $\beta = 45° - f = 45° - 3°\ 45' = 41°\ 15'$

$$\text{Distance } M = \frac{O}{2} - 0.45\ C = 2.102 - 0.225 = 1.877 \text{ inch}$$

Distance $H = Y \times \cos\alpha = \frac{7}{8} \times 0.66610 = 0.583$ inch

Number of teeth for which to select cutter $= N \times 1.4142 = 25 \times 1.4142 = 35$ teeth.

Example 3. Bevel Gears (Shaft Angle 90 Deg.)

Given: No. teeth of pinion $N = 27$, No. teeth of gear $N_1 = 45$, dia. pitch $P = 8$, face $Y = \frac{3}{4}$ inch.

PINION.

$$\text{Pitch diameter } D = \frac{N}{P} = \frac{27}{8} = 3.375 \text{ inches}$$

$$\text{Tan } \phi = \frac{N}{N_1} = \frac{27}{45} = 0.600,\ \phi = 30°\ 58'$$

$$\text{Outside diameter } O = D + \frac{2\cos\phi}{P} = 3.375 + \frac{2 \times 0.85747}{8}$$

$$= 3.375 + 0.214 = 3.589 \text{ inches}$$

$$\text{Tan } s = \frac{2\sin\phi}{N} = \frac{1.02908}{27} = 0.03811,\ s = 2°\ 11'$$

$$\text{Tan } f = \frac{2.314\sin\phi}{N} = \frac{1.19065}{27} = 0.04410,\ f = 2°\ 32'$$

Turning angle $\alpha = \phi + s = 30°\ 58' + 2°\ 11' = 33°\ 9'$

Cutting angle $\beta = \phi - f = 30°\ 58' - 2°\ 32' = 28°\ 26'$

$$\text{Distance } M = \frac{O_1}{2} - \frac{2\sin\phi}{P} = 2.877 - 0.129 = 2.748 \text{ ins.}$$

(The value of O_1 is obtained from the calculations for the gear, which follow.)

Distance $H = Y \times \cos\alpha = 0.75 \times 0.83724 = 0.628$ inch

Number of teeth for which to select cutter:

$$\frac{N}{\cos\phi} = \frac{27}{0.85747} = 31 \text{ teeth.}$$

GEAR.

$$D_1 = \frac{N_1}{P} = \frac{45}{8} = 5.625 \text{ inches}$$

$$\phi_1 = 90 - \phi = 90° - 30°\ 58' = 59°\ 2'$$

$$O_1 = D_1 + \frac{2\sin\phi}{P} = 5.625 + \frac{1.02908}{8}$$

$$= 5.625 + 0.129 = 5.754 \text{ inches}$$

$$\alpha_1 = \phi_1 + s = 59°\ 2' + 2°\ 11' = 61°\ 13'$$

$$\beta_1 = \phi_1 - f = 59°\ 2' - 2°\ 32' = 56°\ 30'$$

$$M_1 = \frac{O}{2} - \frac{2\cos\phi}{P} = 1.795 - 0.214 = 1.581 \text{ inch}$$

$$H_1 = Y \times \cos\alpha_1 = 0.75 \times 0.48150 = 0.361 \text{ inch}$$

Number of teeth for which to select cutter:

$$\frac{N_1}{\sin\phi} = \frac{45}{0.51454} = 87 \text{ teeth.}$$

Example 4. Bevel Gears (Shaft Angle less than 90 Deg.)

Given: No. teeth of pinion $N = 15$, No. teeth of gear $N_1 = 30$, shaft angle $x = 60°$, dia. pitch $P = 6$, face $Y = 1\frac{1}{4}$ inch

PINION.

$$\text{Pitch diameter } D = \frac{N}{P} = \frac{15}{6} = 2.5 \text{ inches}$$

$$\tan\phi = \frac{\sin x}{\frac{N_1}{N} + \cos x} = \frac{\sin 60°}{\frac{30}{15} + \cos 60°}$$

$$= \frac{0.86603}{2 + 0.5} = 0.34641$$

$$\phi = 19°\ 6'$$

$$\text{Outside diameter } O = D + \frac{2\cos\phi}{P} = 2.5 + \frac{2 \times 0.94495}{6}$$

$$= 2.815 \text{ inches}$$

$$\tan s = \frac{2\sin\phi}{N} = \frac{2 \times 0.32722}{15} = 0.04363,\ s = 2°\ 30'$$

$$\tan f = \frac{2.314\sin\phi}{N} = \frac{2.314 \times 0.32722}{15} = 0.05048,\ f = 2°\ 53'$$

Turning angle $\alpha = \phi + s = 19°\ 6' + 2°\ 30' = 21°\ 36'$

Cutting angle $\beta = \phi - f = 19°\ 6' - 2°\ 53' = 16°\ 13'$

$$\text{Distance } M = \frac{O}{2} \times \cot\alpha = 1.408 \times 2.52571$$

$$= 3.556 \text{ inches.}$$

Distance $H = Y \times \cos\alpha = 1.25 \times 0.92978 = 1.162$ inch.

Number of teeth for which to select cutter:

$$\frac{N}{\cos\phi} = \frac{15}{0.94495} = 16 \text{ teeth.}$$

GEAR.

$$D_1 = \frac{N_1}{P} = \frac{30}{6} = 5 \text{ inches}$$

$$\phi_1 = x - \phi = 60° - 19°\ 6' = 40°\ 54'$$

$$O_1 = D_1 + \frac{2\cos\phi_1}{P} = 5 + \frac{2 \times 0.75585}{6} = 5.252 \text{ inches}$$

$$\alpha_1 = \phi_1 + s = 40°\ 54' + 2°\ 30' = 43°\ 24'$$

$$\beta_1 = \phi_1 - f = 40°\ 54' - 2°\ 53' = 38°\ 1'$$

$$M_1 = \frac{O_1}{2} \times \cot\alpha_1 = 2.626 \times 1.05747 = 2.777 \text{ inches}$$

$$H_1 = Y \times \cos\alpha_1 = 1.25 \times 0.72657 = 0.908 \text{ inch}$$

Number of teeth for which to select cutter:

$$\frac{N_1}{\cos\phi_1} = \frac{30}{0.75585} = 40 \text{ teeth.}$$

Example 5. Bevel Gears (Shaft Angle more than 90 Deg.)

Given: No. teeth of pinion $N = 18$, No. teeth of gear $N_1 = 30$. shaft angle $x = 105°$, dia. pitch $P = 6$, face $Y = \frac{3}{4}$ inch,

PINION.

$$\text{Pitch diameter } D = \frac{N}{P} = \frac{18}{6} = 3 \text{ inches}$$

$$\tan\phi = \frac{\cos(x - 90°)}{\frac{N_1}{N} - \sin(x - 90°)} = \frac{\cos 15°}{\frac{30}{18} - \sin 15°}$$

$$= \frac{0.96593}{1.66666 - 0.25882} = 0.68611,$$

$$\phi = 34°\ 27'$$

$$\text{Outside diameter } O = D + \frac{2\cos\phi}{P} = 3 + \frac{2 \times 0.82462}{6}$$

$$= 3.275 \text{ inches}$$

$$\tan s = \frac{2\sin\phi}{N} = \frac{2 \times 0.56569}{18} = 0.06285,\ s = 3°\ 36'$$

$$\tan f = \frac{2.314\sin\phi}{N} = \frac{2.314 \times 0.56569}{18} = 0.07272,$$

$$f = 4°\ 10'$$

Turning angle $\alpha = \phi + s = 34°\ 27' + 3°\ 36' = 38°\ 3'$

Cutting angle $\beta = \phi - f = 34°\ 27' - 4°\ 10' = 30°\ 17'$

$$\text{Distance } M = \frac{O}{2} \times \cot\alpha = 1.637 \times 1.27764$$

$$= 2.091 \text{ inches}$$

Distance $H = Y \times \cos\alpha = 0.75 \times 0.78747 = 0.5906$ inch

Number of teeth for which to select cutter:

$$\frac{N}{\cos\phi} = \frac{18}{0.82462} = 22 \text{ teeth.}$$

GEAR.

$$D_1 = \frac{N_1}{P} = \frac{30}{6} = 5 \text{ inches}$$

$$\phi_1 = x - \phi = 105° - 34°\ 27' = 70°\ 33'$$

$$O_1 = D_1 + \frac{2\cos\phi_1}{P} = 5 + \frac{2 \times 0.33298}{6} = 5.111 \text{ inches}$$

$$\alpha_1 = \phi_1 + s = 70°\ 33' + 3°\ 36' = 74°\ 9'$$

$$\beta_1 = \phi_1 - f = 70°\ 33' - 4°\ 10' = 66°\ 23'$$

$$M_1 = \frac{O_1}{2} \times \cot\alpha_1 = 2.555 \times 0.28391 = 0.725 \text{ inch}$$

$$H_1 = Y \times \cos\alpha_1 = 0.75 \times 0.27312 = 0.205 \text{ inch}$$

Number of teeth for which to select cutter:

$$\frac{N_1}{\cos\phi_1} = \frac{30}{0.33298} = 90 \text{ teeth.}$$

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A GAS ENGINE WRITE-UP.

We recently received a description of a new gas engine having a most extraordinary introduction, as follows:

"A Miracle of Simplicity, Efficiency, and Economy! The Evolution of Power, from the primitive steam engine, crude and imperfect, but containing the principle which made possible the monsters of iron and steel, which have revolutionized the world, to the new mechanical marvel, the gas or air expansion engine, includes the history of all modern progress and all modern civilization. With the steam engine, wonders were done—with the gas engine miracles have happened. With its aid, navigation of the air is an accomplished fact—automobiles skim the earth at a speed deemed, a few years ago, unattainable—submarine boats dive into the depths of the seas like ducks—and Power, which has multiplied a million-fold the productive capacity of human hands, has been placed within reach of even the farmer, to aid the bounty of Nature."

And then down, bump, we come from the empyrean to a description of the "perfect" gas engine. This matter, sent with electrotype cuts to all the trade journals, is assumed by the misguided press agent to be the kind of stuff that sells goods. But it is not so, for the methods of Tody Hamilton, the veteran Barnum & Bailey advertising manager, do not apply well to descriptions of machinery. A plain, matter-of-fact article, pointing out the new features of design and the advantages claimed, is generally best. Over-statement weakens the strength of any claim, and when couched in such extravagant language as given above, it becomes ridiculous.

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A curious gas engine break-down was described in a recent issue of the *Mechanical Engineer*. The connecting-rod broke on account of insufficient lubrication for the cross-head pin in the trunk piston. The engine was running satisfactorily when the rod broke without warning about a quarter of the length of the rod from the wrist-pin. Immediate examination discovered that the two broken ends of the connecting-rod were "blue hot," and when a rope was tied around the broken shank to pull the piston out of the cylinder, the rod was found hot enough to burn the rope. The fracture was due to the rapid bending of the rod back and forth, the wrist-pin bearing having seized on the pin. The rapid bending of the rod had raised its temperature in the same manner as a wire heats up when bent back and forth with the fingers.

TO FIND THE RADIUS, HAVING GIVEN THE ARC AND THE MIDDLE ORDINATE.

Referring to the problem of finding the radius of an arc having given only the length of the arc and its middle ordinate, of which we have had some discussion recently in the letters department and in "How and Why," Mr. J. J. Clark, manager of the text-book department of the International Correspondence Schools, Scranton, Pa., writes us that a member of their faculty has worked out the following formulas which give close results in the extreme cases of the semi-circle and an arc of 120 degrees, and still closer approximations when the arc is short, as will be seen in the last example:

Let $d =$ the diameter,

$l =$ length of the arc,

$h =$ middle ordinate (which of course is the versed sine of half the arc).

$$n = \frac{h}{3\,l}.$$

Then the following formula can be applied, first determining the value of n for convenience in working out the equations:

$$d = l\left(\frac{17 - 60\,n^2 + 8\sqrt{1-60\,n^2}}{300\,n}\right)$$

If n is small, the formula may be shortened to

$$d = l\left(\frac{1}{12\,n} - n\right), \text{ or, more accurately,}$$

$$d = \left[\left(\frac{l}{2\,h}\right)^2 - \frac{1}{3} - \left(\frac{2\,h}{3\,l}\right)^2\right] h$$

For a semi-circle, the first formula gives $d = 2.0609$
the second formula gives $d = 2.1341$
the third formula gives $d = 2.08905$

For an arc 120 degrees, the first formula gives $d = 2.01074$
the second formula gives $d = 2.03622$
the third formula gives $d = 2.01861$

d should, of course, equal 2 in all cases.

The third formula perhaps is the most convenient to use and is quite accurate enough for most practical purposes. Below is given an example in which the length of the arc is short:

$l = 0.5236$ $\qquad h = 0.03407$

$$n = \frac{0.03407}{1.5708} = 0.0216$$

$$\text{Then } d = \left[\left(\frac{0.5236}{0.06814}\right)^2 - \frac{1}{3} - \left(\frac{0.06814}{1.5708}\right)^2\right] 0.03407$$
$$= 2.00165$$

The actual diameter is 2, the same as before.

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THE SHOP OPERATION SHEETS.

With this issue a series of shop operation sheets is begun which is intended to present, from month to month, methods of procedure for a great variety of machine shop operations, in as clear and concise a manner as possible. These will include examples of lathe, planer, milling machine, drill press and other standard machine work, and bench and erecting work as well. In general, each operation will be illustrated, and the effort will be made to show as much as possible in the cuts, reducing the description to steps arranged in logical order and worded in the shortest manner. Some operations may require more space than can be given in one issue, and on the other hand some may require only one section of a sheet. Consequently, it will not be attempted to invariably make each sheet complete in itself, or to have each sheet pertain to one subject alone. In a year thirty-six shop operations will be given to each subscriber, in convenient shape for filing or binding, and in the course of a few years we hope to gather together in this shape the best exposition of machine shop practice, simply presented, that ever has been published. Suitable contributions for these sheets will be accepted from our readers. For further information write to the Editor.

MULTIPLE SPINDLE ATTACHMENT FOR UPRIGHT DRILLS.

OSCAR E. PERRIGO.

In many classes of manufacturing work, and particularly in small or moderate sized jig work, a multiple spindle drill is not only very desirable, but in some cases a positive necessity when we come to consider the question of the quantity of the output. While there are a number of very ingenious and well designed drill holders by means of which drills of different diameters may very quickly be substituted for each other, the operations, however rapid, must consume some time. If we were to make an accurate time study in detail, including every motion from the time the operator picks up his piece of work until he lays it down after having completed the designated operation upon it, we should frequently be surprised at the large percentage of time spent in handling the tools, the jig, or the fixture and the work, in comparison with the time employed in the actual operation of the tool. Considerable time must be employed in these time studies if we are to fully realize the importance of reducing the *handling* time, for therein lies the broader and easier field for improvement in reducing the operating time, and hence the cost of machining the product.

It is much more often the case that good, single spindle drills are at hand than that we have those provided with multiple spindles. The present properous conditions of all manufacturing operations have created such demands for all classes of machine tools that it is well nigh impossible to obtain them at short notice or when they are most wanted. It was under these conditions, and from considerations of this character, that the multiple spindle attachment about to be described was designed. The upright drill which was available for this purpose had a circular table about 30 inches in diameter, and a 2½-inch spindle.

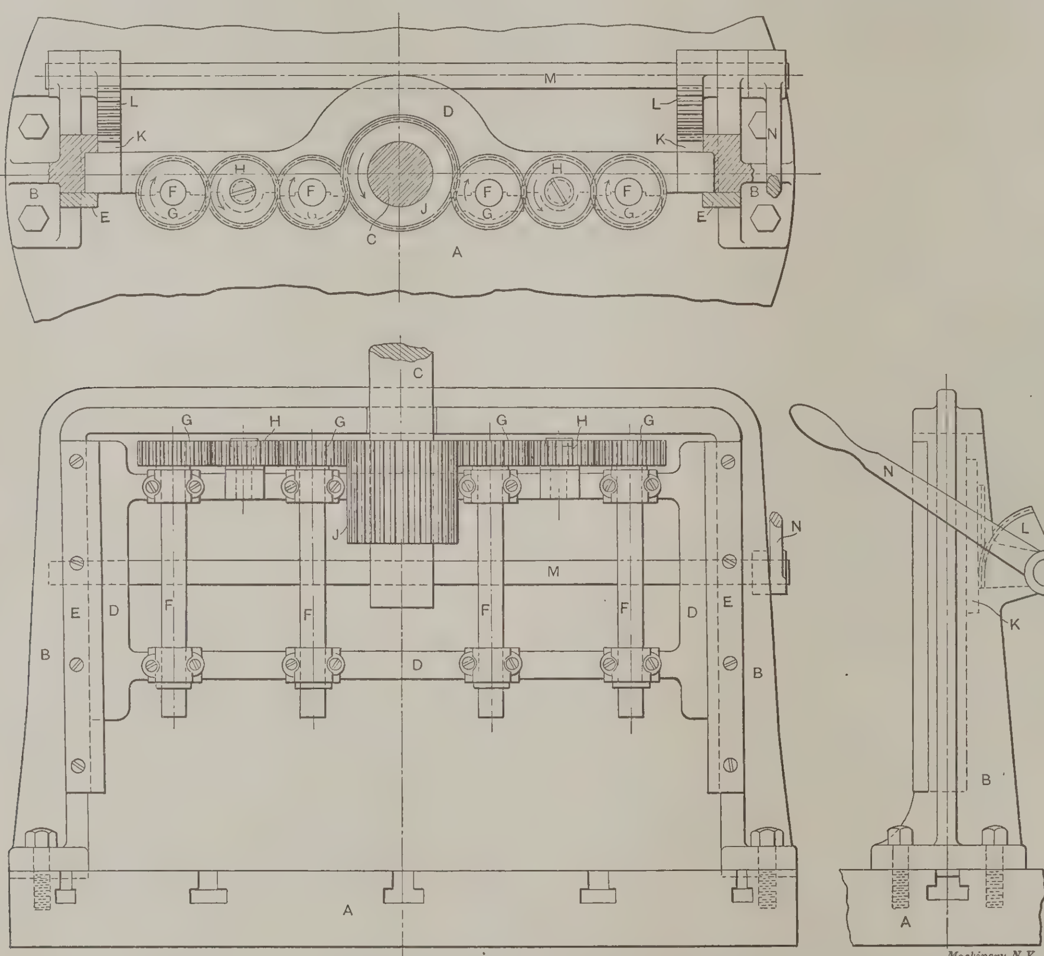
Referring to the cut, the front elevation of the attachment shows the method of its fastening to the table. The end elevation shows the method of feeding the drills by a single lever, in connection with a rack and segment. A plan and partial horizontal section is shown, where the top member of the main frame has been omitted in order to more clearly show the driving mechanism. The general construction of the device is as follows: Upon the drill table A is bolted the main frame B, secured by bolts as clearly shown in the cut, The main spindle C of the drill passes down in front of the center of this fixed frame, its top member being cut away for that purpose as shown in top view. Sliding vertically in the frame B is fitted the spindle frame D, held in place by the gibs $E\,E$, and having journaled in it the drill spindles $F\,F\,F\,F$, upon whose upper ends are fixed the spur pinions $G\,G\,G\,G$, by which they are driven. The pair of spindles on each side of the drill spindle C have their driving pinions connected by idle pinions $H\,H$, and the power communicated to the entire train by the elongated gear J, fixed to the drill spindle C. The idle pinions $H\,H$ run upon studs screwed into the top member of the sliding frame D. The gear J is of sufficient width of face to transmit the power to the auxiliary drill spindles $F\,F\,F\,F$ at any point within the limit of their vertical movement.

The movement of the sliding frame D is accomplished by means of the racks $K\,K$, attached to its rear side, and engaged by the toothed segments $L\,L$, fixed to the rock shaft M, which is journaled in rearwardly projecting brackets on the main frame B, and controlled by the hand lever N, by which the drills are fed downward. To balance the weight of the sliding frame D, the lever N may be counterbalanced by a weight formed upon, or attached to, a rear extension of it, or better by spiral springs attached by their lower ends to the sides of the sliding frame D, and their upper ends to the top member of the main frame B. When in operation the main spindle C of the drill is locked in reference to its vertical position so as to properly locate the driving gear J. If the driving belt of the drill be running open it is crossed, so as to give a proper direction to the revolution of the spindles as shown by the arrows. For very light work, and in cases where the noise of the rapidly running gears is objectionable, flat or even round belts may be used, and the expense of the

gears partially avoided. In this case but two belts need be used, an idler being properly placed to give sufficient belt contact to drive the drills.

In case it is necessary to locate the several drill spindles in various positions in relation to each other, so as to drill several holes simultaneously, the idle pinions *H H* may be carried by movable brackets similar to the change gears of an engine lathe. The drill spindles may be journaled in boxes sliding in a slot in the movable frame, or sliding upon the horizontal bars of the frame. It might, for the same reason, be necessary to interpose between the driving gear *J* and the pinions on the drill spindles adjustable idle gears or pinions.

The drill spindles need not necessarily be located in a straight line, but may be so located as to fit the holes in any special piece of work. They may be equally spaced around a circle if much work is to be done of this form. The spindles may be located by radial slots in an upper and lower plate, properly connected so as to constitute a sliding frame, and



Multiple Spindle Attachment for Upright Drills.

running in three or four vertical guides. By this means holes placed in circles of varying diameters may be drilled. In such a device the drill spindles might be driven by one or the other of the methods described above. The practical utility of the device is readily seen, as the ordinary single spindle drill may be easily and economically converted into a useful multiple spindle drill with any desired number of spindles, and located in any desired arrangement.

* * *

The Union Iron Works, San Francisco, Cal., has undertaken what is said to be the heaviest task in the way of repairing a merchant vessel ever undertaken in the United States. It is the removing of the entire bottom of the Pacific mail steamship *Manchuria* which was wrecked on the rocks of the Hawaiian Islands several months ago. The entire bottom will have to be rebuilt. Over 300 shell plates and 90 per cent of the floor plates will be replaced. The job will employ 600 men and will require 1,560 12 x 12-inch timbers for shores. Notwithstanding the greatness of the job it is expected that it will be completed in four months time.

SUGGESTED REFINEMENT IN THE HOBBING OF WORM-WHEELS.

R. E. FLANDERS.

At the right of Fig. 1 is a sectional view showing a hob in the act of putting the last finishing touches on a worm-wheel. The hob is supposed to be a new one and is shown in the condition it is when first received from the makers. At the left of Fig. 1 is shown the same hob putting the finishing touches on a worm-wheel similar to that in the first case. The hob in this case is represented as having been in use for a considerable time, and having been ground down to the last extremity, ready to be discarded for a new one. A study of this cut will show that if the hob is made in the first place to properly match the worm which is to drive the wheel, it will not, when worn, cut exactly the proper form of tooth in the blank to mesh with that worm. The teeth are cut to the same depth in each case, this being necessary in order to make a proper fit with the worm, which is the same in each case and it set at the same center distance. The grinding away of the worn hob has reduced its diameter by an amount indicated by dimension *b*. Its center is therefore at *P* on the line *A B*, which is offset by a distance represented by dimension *a* from the line *C D* in which the center *O* of the new hob is located. This reduction in diameter as the hob is ground away from time to time, so evidently follows from the construction of the relieved hob, that it scarcely needs to be explained.

It is said of relieved hobs that they can be ground without changing their shape. This is true so far as the outline of the cutting edge is concerned, but it will be evident on examining the conditions shown in the left hand of Fig. 1, that whatever the outline of the cutting edges, a new hob of radius *R* will not cut exactly the same shape teeth in the blank as the worn hob with radius *r*. The elements of the tooth surface it generates are struck from a center *P*, removed by dimension *a* from center *O′* which is the location of the axis of the worm with which it meshes.

It is possible, and perhaps practicable, to overcome this slight error; that is, to so design and use the hob that it will cut as correct teeth when worn as when new. In Fig. 2, dotted line *A A* represents the outlines of a new hob in the act of finishing the worm-wheel shown. Were a hob, ground as shown at the left of Fig. 1, to be substituted on the arbor for this new hob, without altering the adjustment of the machine except to move the hob endwise and bring it in contact with the teeth of the wheel on one side, this hob would be represented in Fig. 2 by the full line *B B*. It is evident that the left hand cutting edges of this hob coincide (to the depth they extend into the wheel) with those of the new hob represented by outline *A A*. They will, therefore, so far as they extend, cut identically similar and correct tooth curves with the new hob.

Teeth cut with this worn hob would, however, evidently

have two faults. The space would be too narrow at the pitch line by a distance measured by dimension m, and they would not be cut deep enough in the blank by a distance measured by dimension n. Our problem is to so alter the design and application of the hob, that, even when it is worn, we can cut the teeth deep enough and the space wide enough.

Fig. 3 shows these conditions fulfilled. Dotted line $C\,C$ shows the outline of the proposed hob when new. The only difference between the proposed hob and the regular one, whose outlines are shown by the dotted line $A\,A$ in Fig. 2, is that the teeth have been lengthened by an amount equal to dimension o. The hob is fed in as was the case with the new hob in Fig. 2 until the distance between its center line and that of the blank is the same as that between the center line of the worm and the wheel in the finished machine. The increase in radius, then, by an amount o, makes the hob cut a clearance deeper than is necessary by that amount. In a spur gear this would doubtless be a bad thing, since it would make the tooth slenderer and therefore weaker. A worm gear, however, if designed to be sufficiently durable for continuous use, is almost certain to be several times stronger than necessary, so that the slight weakening involved in the change is not of great importance. When the hob is worn to the shape shown by the full outline $D\,D$, the hob is evidently of the same diameter as the new one in Fig. 2, represented by dotted outline $A\,A$. Our tooth space, however, as before explained, will be too narrow by the amount m in Fig. 2 or p in Fig. 3. To widen it out sufficiently, it is therefore necessary for us, after the hob has been fed in to the proper depth, to still continue the cutting action, feeding the hob endwise, however, until it has been displaced to the position indicated by outlines $D'\,D'$. The resulting tooth is evidently identical with that given by the new hob $A\,A$ in Fig. 2.

It will be understood that when the hob in Fig. 3 is new, it will not have to be shifted endwise at all, since it will cut a tooth space of the proper width as soon as fed to depth. It will, however, cut a space deeper than necessary by an amount o. The worn hob, on the other hand, has to be shifted longitudinally by an amount p and cuts to exactly the required

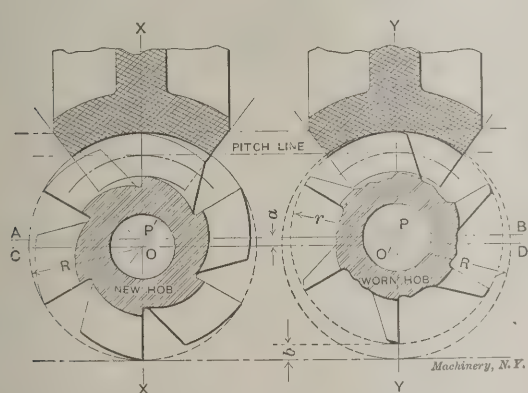


Fig. 1. The Difference in Shape of Teeth Cut by New and Old Hobs.

depth. These represent the two extreme conditions. When the hob is half worn, the excess clearance will be equal to half of o, and the longitudinal displacement necessary will be equal to half of p.

While the change in the design of the hob could be made easily enough, there is doubtless some difficulty in making the required change in the hobbing of the blank. Taking it for granted that the hob has been made to suit the worm which is to be used, and that it, therefore, has the same pitch diameter and thickness of tooth at the pitch line, the method of procedure will invariably require that the hob be fed in to the worm-wheel blank until the distance from the center of the hob to that of the wheel, is the same as the distance from the center of the worm to that of the wheel in the finished machine. This will be true whether the hob is new or worn, and whatever may be the kind of machine on which the hobbing is being done.

The method by which the hob is displaced longitudinally will depend on the machine used for the operation. There will be no possible way of doing it if the wheel is being finished while running loosely on centers, as is common practice when the blank has first been gashed. It is required that the hob and blank be positively geared together. If a positively driven hobbing attachment in the milling machine is being used, the matter is simple. If the hob is being driven by the spindle of the machine, throw in the cross feed in either direction until the required longitudinal displacement of the wheel with relation to the hob has taken place. The question as to when this has taken place may be decided either by measuring the thickness of the tooth, as in cutting spur gears, or by trying the wheel from time to time with its worm, the two parts being mounted in place in the machine they are to go in, or held the proper distance apart by other means.

For regular hobbing machines, as at present made, the matter is more difficult. The required longitudinal displacement of the hob may be obtained, in effect, by a rotary displacement of the hob which may be accomplished by slipping (a

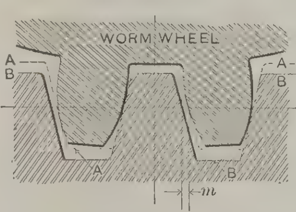


Fig. 2. Cutting Action of Ordinary Hob at Fixed Center Distance, when new and when worn.

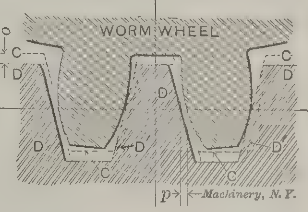


Fig. 3. Cutting Action of Proposed Hob, when new and when old.

tooth at a time), the teeth of the change gears connecting the hob and the blank. If a hobbing machine were to be built especially for use in the way suggested in this article, differential gearing could be introduced in the train between the hob and the wheel, to which a power feed could be given to effect the rotary displacement when the hob had been fed to depth; or a power feed might be applied to feed the spindle and its attached hob endwise to effect the same result.

The writer is not certain that the error which exists in the use of relieved hobs is of enough importance to warrant taking any trouble to remedy it. It is always well, however, to know and understand such errors as may exist in any process of this sort, no matter if they are of no great practical importance. While some designers and shop men have doubtless recognized the existence of this particular error, still probably most of them take it for granted that the process is absolutely accurate, since they are so often reminded that the relieved hob can be "ground without change of shape."

* * *

AN EXAMPLE OF THE RESISTING POWER OF SOFT MATERIALS.

In dealing with automatic machinery, experimenters have often found most surprising results in the use of soft materials, where harder ones have failed to stand the racket. In a recent article in a contemporary, for instance, was described the difficulty experienced by a manufacturer with the feed rolls for a wire drawing machine. Although made of the best steel obtainable, hardened and toughened to the highest degree, these rolls still rapidly wore away under the friction of the stock they were feeding. The problem of making durable feed rolls was finally solved by making them of *annealed* steel. When this principle was discovered and applied, no further difficulty was met with.

Another case illustrating the resistance of soft materials to wear came to our notice a few days ago. It was an incident of an entirely different character, but illustrates the same principle. A split box carrying the feed shaft on a certain woodworking machine was too tight, so that it caused the bearing to heat. The operator inserted a slip of paper under the cap on one side. This slip of paper was so long that it projected beyond the shaft, within the range of a projecting set screw in a collar on the shaft, which struck it at every revolution—that is to say, about 100 or 120 times per minute. The set screw struck this paper for practically a full working day, every working day for seven years, without destroying the elasticity of the paper or entirely wearing it away. The screw, meanwhile, had been polished bright and perceptibly worn by the friction of the paper.

MACHINERY'S NEW OFFICES.

The above illustration shows the twelve-story building in which MACHINERY's offices are now located, at 49-55 Lafayette Street, corner of Leonard, being one block east of Broadway and four blocks north of City Hall Park. Lafayette Street, formerly Elm, extends from Reade Street to Astor Place, and is the route of the Subway from Worth Street to Astor Place. It will be noted that one of the kiosk entrances to the Subway shows in the accompanying illustration at the right of the first building beyond, and in the distance is seen a portion of the roof of the magnificent Hall of Records, recently completed. The new location is one of the most convenient in downtown New York, being near the Brooklyn Bridge and the Subway, which latter already gives quick communication throughout the length of Manhattan Island and beyond. Later it will communicate directly with the Brooklyn Subway, and the great Hudson Tunnel system.

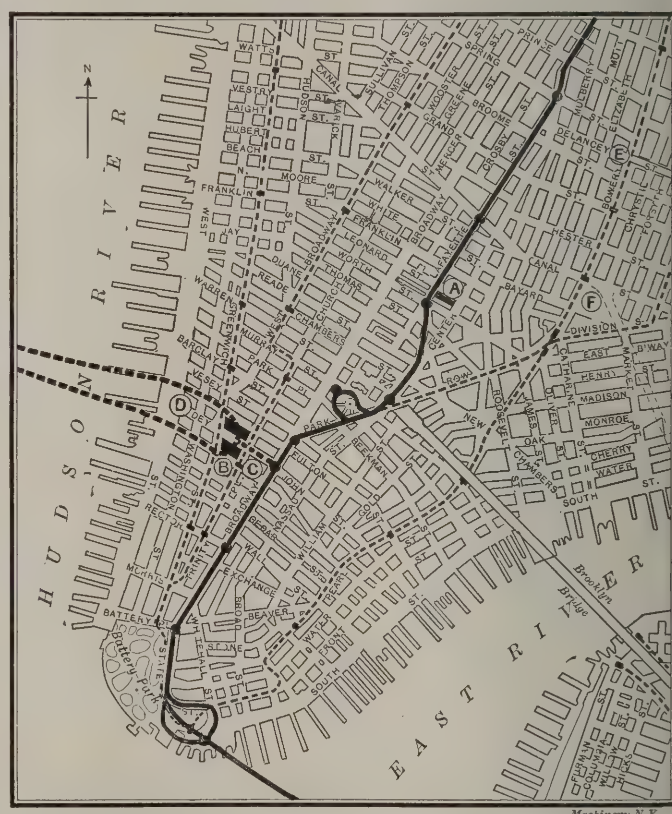
This part of the city is of considerable historic interest. It is near the site of the old "Collect," a pond which for a brief time about one hundred and thirty years ago was the city's water reservoir, and later became a dismal and dangerous stagnant pool, in which the town people threw dead cats and dogs—and sometimes men as well. The real estate within a stone throw's radius of the site of the old pond is to-day valued far up in the millions.

The building is a good example of modern skyscraper construction, being fireproof and especially adapted to our requirements. A ten-year lease has been taken of the eighth floor, having an area of 6,500 square feet, which we hope will accommodate our business for some years to come, although a continuation of its proportionate growth during the past fifteen years may oblige us to take additional space before the termination of our lease. The central location, which is shown on the map in the next column, makes it convenient for all our friends who visit New York to call on us, and we extend to them a cordial invitation to do so.

THE MACHINERY AND METAL CLUB.

The demolition of the two blocks bounded by Cortlandt, Dey, Fulton and Church Streets, in the center of the machinery district of New York City, to make room for the Hudson Tunnel Terminal Buildings, dislodged a large number of firms in this trade; and on account of the difficulty of obtaining warerooms, a number of them contemplated moving uptown on the theory that proximity to the hotels would prove a convenience to visiting buyers. The fact that a move of this kind would result in spreading the trade over a wide area was lost sight of.

The great advantage to the machinery trade of continuing in its present central location, which can be quickly reached from every point, was at once seen by Mr. Francis H. Stillman, president of the Watson-Stillman Company, who set about the organization of a Machinery and Metal Club that would both fill an existing want and help to insure the continuation of those trades in their present location. In response to a circular letter sent out by Mr. Stillman a large meeting of those interested was held early last month, and an organization committee appointed to take the necessary steps for the formation of the club, the success of which appears to be assured, as more than four hundred applications have been received by Mr. Stillman alone, which number does not include other names received by members of the committee. An option has been secured on two floors of the Fulton Building,



Map showing Location of the Hudson Tunnel Terminal Buildings and also of MACHINERY'S New Offices.

A.—MACHINERY'S new office. B.—Hudson Tunnel Terminal Building. C.—Subway Foot-path under Dey Street. D.—Hudson & Manhattan R. R. Co.'s Twin Tunnels. E.—Approach to the new East River (Williamsburg) Bridge. F.—Approach to Manhattan Bridge, now building.

one of the buildings forming the great terminal property which will be practically the center of the Subway and tunnel system of New York and vicinity. The map on this page shows at a glance the convenience of the location and its accessibility to various points in and near New York.

In connection with this movement, Mr. Stillman has also in mind the erection of extensive warehouses at the Jersey City end of the tunnel, which will be but a few minutes from the Terminal buildings, and which will afford ample storage and show room facilities at a far lower rental than can be obtained on Manhattan Island.

* * *

A good mechanic will not use a hammer and set to tighten or loosen a nut, but it would be a very poor mechanic who would not know enough to use this handy expedient in an emergency if a wrench were not at hand.

LETTERS UPON PRACTICAL SUBJECTS.

METHOD OF REPAIRING TWIST DRILLS WITH BROKEN TANGS.

The object of the accompanying cuts is to show how I propose to get out of doing one of the most unwelcome jobs as it is usually done by substituting a method which will not only save the necessity of turning up the shanks of this pile of drills, but which will prevent a similar pile from ever being sent into the tool-room for shank repairs again. To the right in the cut, Fig. 1, will be noticed sockets or collets having been made with a flat section running the entire

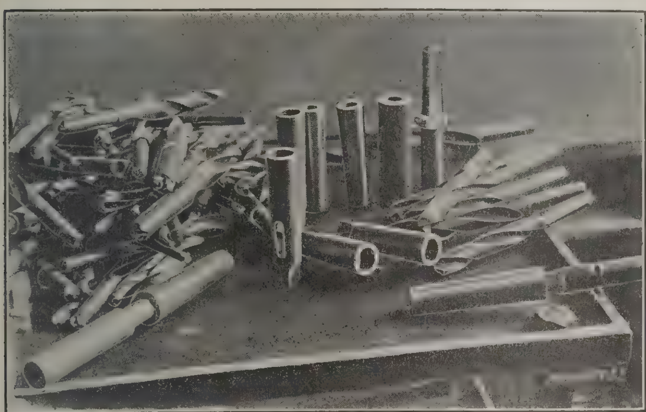


Fig. 1. Collection of Drills with Broken Tangs, and Sockets for Repaired Drills without Tangs.

length of the taper hole. A corresponding flat is made on the shank of the drill. I have demonstrated by actual test that the drill will break before allowing the shank to twist. The manner in which these collets are made may give some sensitive tool-room autocrats a shock, but nevertheless excellent results can be obtained by the method adopted.

First, take a bar of machine steel about 3/16 inch larger than the large end of the collets to be made. If you can do this job in a turret lathe, so much the better; if not, cut up the bar in lengths to suit the collets being made, drill a hole

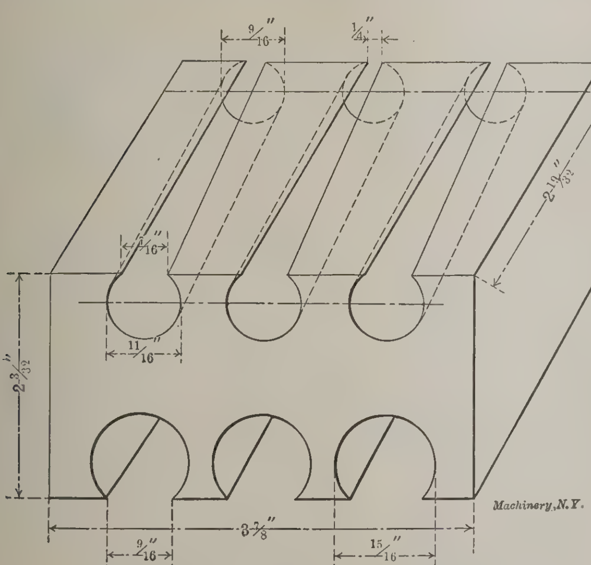


Fig. 2. Device for Milling Flat on Taper Shanks.

in the blanks about ¼ inch deeper than the length of taper shank of the drills, and 1/32 inch larger than small end of the drill shank. Then make the two taper drifts shown in Fig. 1. One should be smaller than the drill shank and have a less steep taper; the second one should be made the same size and taper as the drill shank for which the collet is to be used. Heat the blank and drive in the first drift, and use the flattener to form the flat section. Then remove the drift, reheat the blank, and drive in number two drift up to the shoulder, using the flattener again to complete the formation of the flat section of the hole. If ordinary care is exercised by the toolsmith an excellent job can be made. After the hole has been polished up, and the outside of the blank turned, it will keep some men guessing as to how it was made. The blanks are now turned up on the special arbor shown. The nut is used to take them off the arbor after having turned them.

Fig. 2 shows a milling fixture used for milling the flats on the drill shanks, three or more at a time, which scarcely requires any explanation. The taper holes are made to suit the various sizes of drill shanks, and afterward cut away to allow the shanks to project the amount it is desired to mill off. I have found that for number one Morse taper shank a 5/16-inch wide flat at the large end is about right; for number two taper shank, 7/16 inch, and for number three taper shank 9/16 inch wide flat is correct. By starting the milling cutter at the large end and feeding toward the small end, this fixture works very successfully, and I have had all the drills in the shop milled for these sockets, so that I believe there will be no more broken drill shanks to repair here. I would specially recommend these sockets to be used where drilling is being done with air motors, as my experience is that far more tangs are twisted off in air motors than in machines. OBSERVER.

SPRING COLLET FOR HOLDING WORK BY THE INSIDE.

The accompanying cuts show a spring collet which I have made and used in reboring brass bushings which have been pressed into a casehardened clutch. Part *A*, Fig. 1, is the clutch and *B* the bushing. The clutches are made of machine steel, and are a combination roller ratchet and clutch. The section at *C* shows the roller race. Now we find that after

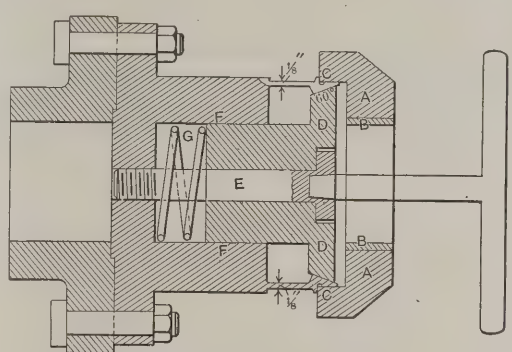


Fig. 1. Spring Collet for Holding Rings, Etc., by the Inside.

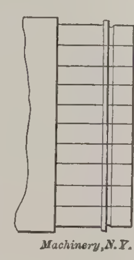


Fig. 2. Slits Cut in End of Collet to produce Spring Action.

casehardening, the clutches change their shape considerably, some more than others. The roller races, though bored very accurately to plug gage, vary in size after hardening, from 0.002 to 0.012 inch in diameter. Nor does the bore of the clutch into which the brass bushing is to be pressed remain true with the roller race, which is important, as it should be as near right as possible.

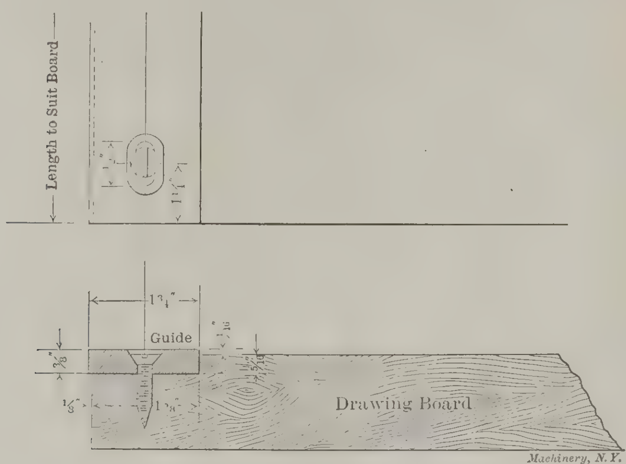
The company does not care to spend the extra time and money that it would cost to grind the bore and roller race to exact diameters, true with each other, so we rebore the bushings after they have been pressed into the clutches, using the collet shown in the sketch to hold the clutches during the operation. The variation in diameter of the roller race, as stated above, prevents our using a solid plug for locating the clutch, but the variations do not injure the clutch, it being important only that the roller race should be concentric with the bore of the brass bushing, which is the bearing. We have found our method very satisfactory, as no time is lost in chucking. We move the taper plug *D* in or out by means of the screw *E*. This takes up the variation in the diameter of the bore of the roller race and holds the piece securely with very little pressure, and after the bushings are rebored, they are found to be very nearly true with the roller race. In boring the bushings, after the boring tool is once set to bore the hole to proper size, the gib is tightened on the cross carriage and a great many are bored without changing the tool. The bushings are bored to a running fit. They are finished all over before pressing into the clutch, except the bore,

which is left about 0.010 inch large to allow for reboring. I hardly think the jig needs much explanation as it is shown quite plainly in the sketch. The plug *D* is a close fit in the body of the jig at *F*, and *G* represents a coil spring. The horizontal lines in Fig. 2 represent the slots sawed with a hacksaw. R. B. CASEY.

Schenectady, N. Y.

GUIDE STRIP FOR DRAWING BOARD.

A great many draftsmen are quite frequently troubled by lines drawn with a T-square not being parallel with each other at different points of the drawing board. This is in-



Guide Strip for Drawing Board.

variably due to the fact that the edge of the drawing board is seldom true. This trouble may be easily overcome by the application of the T-square guide shown in the cut. The left-hand side of the drawing board is cut out 5-16 inch deep by 1⅝ inch wide, the full width of the board, and a bar of steel ⅜ inch by 1¾ inch, length to suit, is inserted; the latter is secured by four screws, the holes for the screws being oblong to allow for any expansion or contraction of the draw-

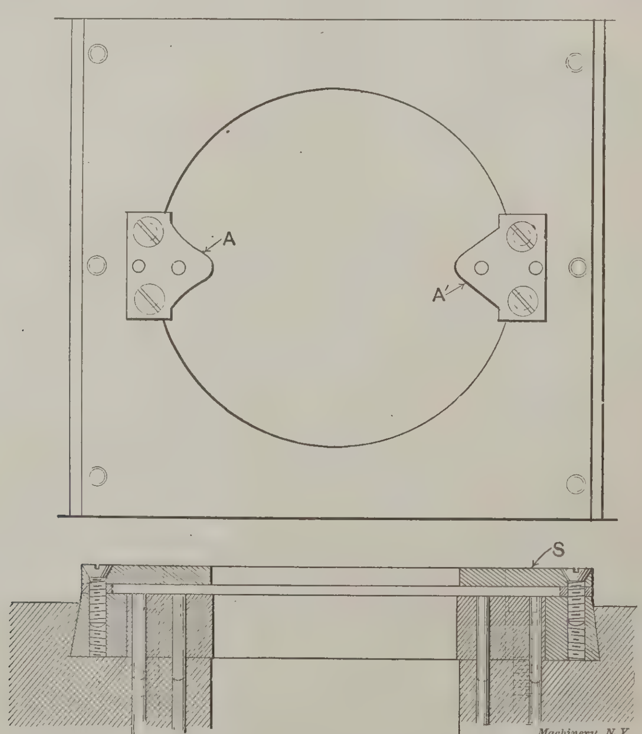


Fig. 1. Die for Outside of Blank.

ing board. This guide, projecting ⅛ inch from the edge of the board, gives a smooth surface for the T-square head and projecting 1-16 inch above the board, as shown, tends to keep the T-square blade just enough above the paper to keep the drawing paper, which is very often soiled by the shifting of the T-square, reasonably clean. Parallel lines at all points on the board are insured by the application of this guide.

Meadville, Pa. J. C. HASSETT.

SECTIONAL PUNCHES AND DIES.

The punches and dies in Figs. 1, 2, 3, and 4 were made for producing the punching Fig. 5, in two operations, and illustrate to some extent sectional die making. As a perfect punching was required in regard to the inside and outside diameters, the design shown was adopted, which proved to be all that could be desired as to accuracy and cost of making, particularly when compared to previous methods and results. In making the punch and die for the first operation, Figs. 1 and 3, the punch was made first. *B* is the punch proper, and *C* is the holder which is made of cast iron. The punch was hardened and screwed and doweled to the holder before grinding the outside diameter to the correct size. Then the die was machined, and after hardening ground to fit the diameter of the punch. The sections *A* and *A'* were then fitted to the die and fastened with the screws and dowel pins as shown, and sheared with the punch. As the sections *A* and *A'* were small, they did not alter any in hardening.

For the second operation, the punch and die, Figs. 2 and 4, were made in the same way, that is, the punch was hardened and ground on the diameter *D*, and the die ground at *E* to fit

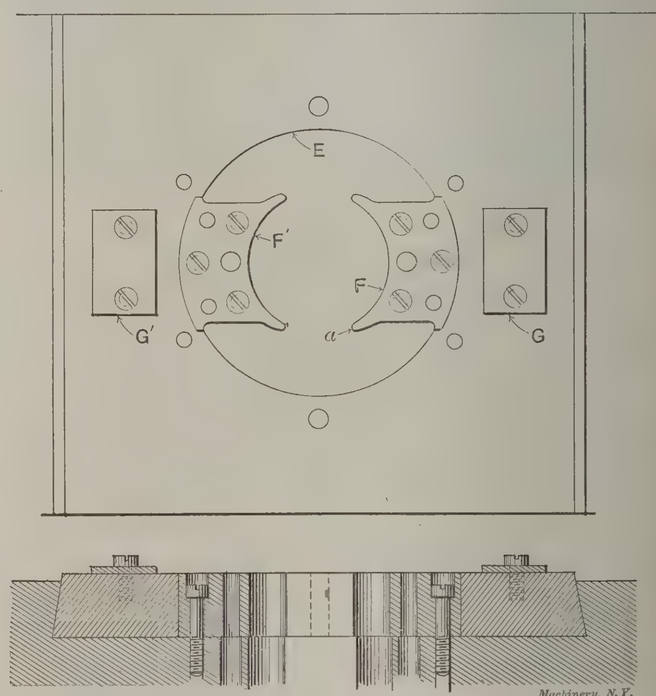


Fig. 2. Die for Inside Shape and Holes.

diameter *D*. The sections *F* and *F'* were then machined in the proper way and sheared by the punch. In hardening the sections *F* and *F'* one of them altered so much at *a* that it had to be discarded and another made. This could have happened had the die been made solid, which would have condemned the whole die, and a new die would have had to be made. The rest of the design is readily understood by referring to cuts Fig. 1, where *S* is the stripper, and Fig. 4, where the stripper is on the punch, the blank being placed on the die guided by strips *G G'*. A. C. L.

DOES A TECHNICAL EDUCATION PAY?

Your readers may remember that an article, "On the Object of Technical Training," was published in the February issue. This article brought forth a letter from a young man, a student at one of the larger technical colleges, and a man absolutely a stranger to me. From this letter I make a few extracts with his permission:

"My case is a typical one. I carried papers and swept in the high school and have waited on table, washed dishes, pulled weeds and worked in our library to keep myself in an engineering school. I read everything I can relative to engineering education and its faults, the outlook as portrayed by the engineering press throughout the country is indeed not very encouraging. . . . If our severe critics could see the hardships that some of the boys put up with—how they deny

themselves sleep, recreation, good health and even live on two meals, they would be a little kindlier in their criticisms."

This boy's picture of his life is not an unusual one; there are great numbers of boys who are wholly or partially earning their way through colleges. Does it pay? Is it worth the sacrifice? The question of whether technical colleges ought to make changes in their work does not affect this case; the only thing to be considered is whether taken as they are, they do a young man enough good to pay. From a money point of view there is not much room for doubt that these chaps almost invariably do well after they have been out a few years. During the first two or three years after graduation is the time when we hear the most criticism. After that they lose in a way their individuality as college men and take their stand among men purely on their own merits. It is only after they have made this change that their employers entrust to them work of sufficient importance, so that they can really use the education they have received. Before that time they are really again freshmen in the school of life, and must expect to be hazed more or less in the same way that they were when they were freshmen in college. When you run across a man in the shops, or on the road or in any engineering work after he is 30 or 35 years old, it is hard to guess whether he came up to his job through the shop or from an engineering school. If that is so, then why is it any better for a boy to go through a college rather than through the shop? My answer is just this: The college road is shorter and is more likely, using the same raw material, to succeed. The shop educated boy learns certain things regarding actual work, use of tools, handling work, etc., better and more thoroughly than the graduate. But if he learns anything of mathematics, of drawing, of design, he does it at a sacrifice of time and strength at least equal to that which the college boy without money may make. He must learn at night and without a teacher at his elbow. He cannot have the advantages of a laboratory, and that is a serious drawback, but he must dig out a great deal for himself, which is an advantage. Again, as a matter of fact, young men 18 years to 21 years old—the time when most boys are in school or are apprentices—are at the age when their minds are most receptive of new facts, yet are at the age when they will not voluntarily make the effort to reach out for new ideas, from books at least. The man in the shop who wakes up to the situation and begins to study from books is usually at least 25 years old when he does it. He has lost his power to study easily, and he is in too much of a hurry to get to something, the use for which he can see, to spend much time on preliminaries and fundamental work. The college boy has this advantage, that in order to stay in school at all, he must go through that preliminary drudgery whether he will or not. He comes out with a mind trained to look at problems in a logical way, but without the ability to take short cuts in the solution of problems which have been of everyday occurrence to the shop man. The chances of a given boy of 18 years amounting to anything in an engineering way are better by the school method than the shop method to-day (the writer believes that the shop method is susceptible of such great improvement as to at least equalize the two, but that is apart from this discussion). The boy may do just as well by the shop method, but it depends more on himself than in the school. The fact that in a school he is associated with other learners and with men whose business it is to teach, and where he has constant incentive to study, is very different from shop associations where there is every incentive to let his study go. If some technical school could make arrangements with some manufacturers or engineers to take their product and work them hard and hide them away for two or three years and only let them out and give them their degree at the end of their practical course, then the reputation of that school might grow, but it would serve no practical purpose better than the present system. It would simply do away with the chance which so-called "practical men" have of making fun of the green technical graduate, because he would be kept in a dry kiln to season for a year or so, instead of being stacked out in the open where everyone could see the sap ooze out.

One other word to any young men who are making sacrifices to get their education. You cannot get anything in this world without making sacrifices. When you get rich you have got to keep straight. You have to remember that you are up where everyone can see you. You are not independent. You cannot be. It is just as hard to do things that you do not want to just because it will make talk if you do, as it is to go hungry. When you have the money to buy privileges which the law says you shall not have, it is no easier to obey the law than it is to go without sleep. You are going to have just about so hard a time just so long as you live. By-and-by you will get used to it and will appreciate any little let-ups that fortune may give you, and when things are going hard you may be thankful that there is such a thing as work in which you may lose yourself, and when things are bright, be thankful that there is work which must be done to keep you from having idle time to put you to your wits' end for something to do for amusement.

ENTROPY.

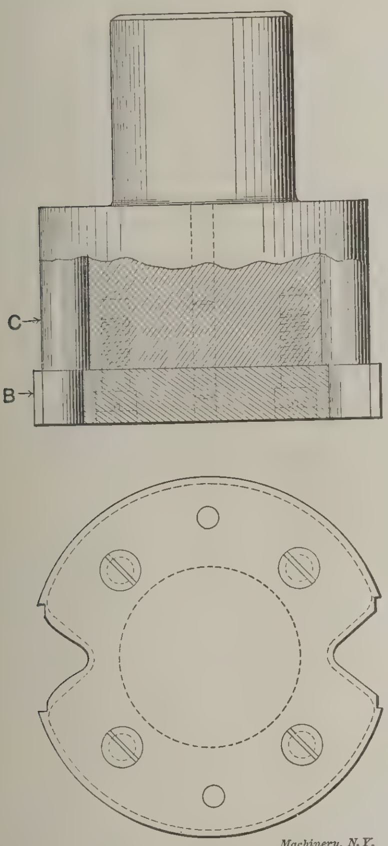


Fig. 3. Punch for Punching Outside of Blank.

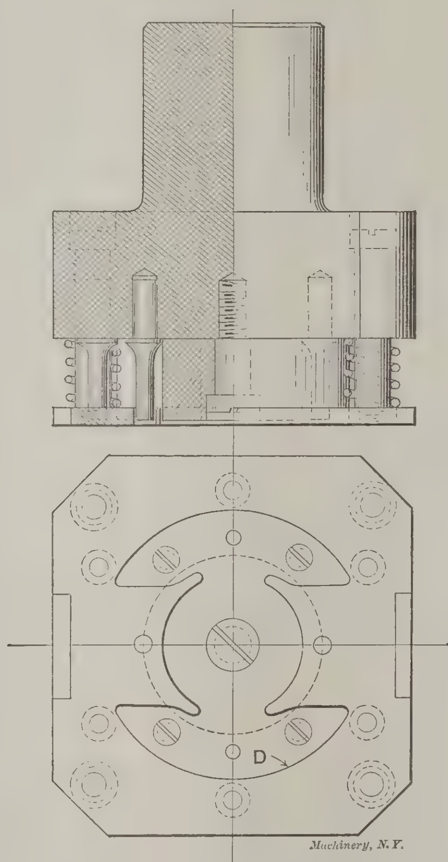


Fig. 4. Punch for Inside Shape and Holes.

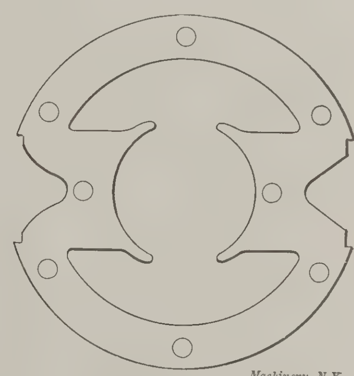
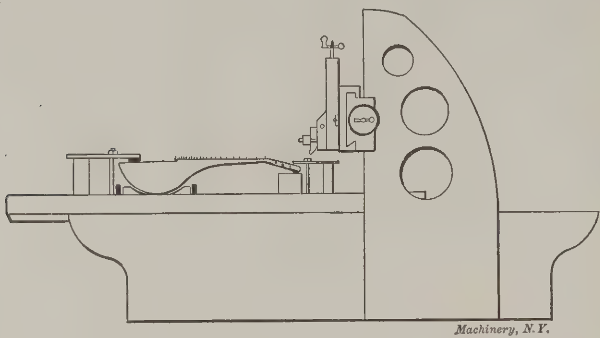


Fig. 5. Finished Punching.

A MUSICAL JOB.

Once I was "holding down a job" in a little repair shop, where I was everything from a casting cleaner to toolmaker. A chap brought in a mandolin one day, and said that the frets were too high. He had been filing them one by one, but could not get them level. As soon as he got one lower than the next, the thing would sound like "The Call of the Wild" or anything but the note desired. The boss told me to "see what I could do." I looked it over and told the chap I would do it in two hours, which meant $1.50 to him. He appeared to want to hang around and see how I went at it, but I had an idea and didn't want to be bothered by too many sugges-



Planing Mandolin Frets.

tions, so I told him I would not be able to start for some time, and he went off with the intention of returning before I began. As soon as he was out of the door I measured the fingerboard and found that it was 9½ inches, or 3 inches too long for the small old shaper, so I clamped it on a 6-foot planer with wooden straps and layers of cotton waste, and in fifteen minutes I had a couple of fine cuts across the brass frets and the job was finished with a few strokes of a fine file on the edges, rounding them to avoid taking chunks of meat out of the player's fingers when he surpassed himself in the flights of harmony.

Our customer was much surprised when he returned to find his instrument lying finished on the bench, and after "stringing it up" he gave us a couple of jigs, and appeared satisfied with the result. He wanted to know how it was done, but I evaded answering, fearing he might imagine I had injured the frail instrument by clamping it, although I had not used a wrench with a 4-foot pipe on the handle. Next day Jimmy, an apprentice, informed me that he had told the chap I had "bitten" off the desired amount. Although I scarcely think this was swallowed, nevertheless there doubtless hangs a cloud of mystery around the fingerboard of that instrument.

W. L. McL.

AN INGENIOUS APPRENTICE.

In a small shop in a city in southern Pennsylvania, there worked a lad of about sixteen years of age. The line of work carried on in this shop was rather general in its character, including the manufacture of steam engines, pumps, boilers, etc. This was no unusual state of affairs, however, in the latter part of the sixties, as almost every shop was more or less of a general repair and job shop.

A man came to the shop one day and asked to have a number of egg-shaped weights made, to be cast of cast-iron and to weigh exactly 12 pounds. The owner and foreman of the shop was somewhat at a loss as to how he should go about making a pattern for the job. His knowledge of higher mathematics did not permit him to make "any accurate calculations." During the day, he spoke to Frank, our young apprentice, of the job and asked him what he thought of it. Heretofore, he had seen that the lad possessed some genius and he determined to try him again. He said, "Frank, I would like to have you make the pattern for that job, if you can." The lad only said, "Well, Mr. Johnson, I can try." Then Mr. Johnson turned and walked away leaving Frank to himself. The boy looked at the order as to what was required and sat down and studied the proposition over. After a few minutes' deliberation, Frank set to work. He constructed a box 4 inches by 4 inches by 3 inches inside dimensions. This he filled with moulder's clay, having just 48 cubic inches of clay, and started the shaping of the clay into an egg. Having carefully shaped the clay until it was about the desired shape, he put it in the coke oven and baked it. After the egg was baked, he took it to the pattern shop and proceeded to turn up his pattern using his clay egg as a guide. Carefully calipering the pattern and being sure that it was a true duplicate of his clay egg, he sent it to the foundry. A casting was made that afternoon, and on its being dumped and cleaned up, it was found to tip the scales at exactly 12 pounds, the desired weight.

On seeing the casting made as required, Mr. Johnson's curiosity got slightly the better of him and he asked Frank just how he did the trick, and he had the whole thing carefully explained to him. The apprentice assumed that by taking the weight of cast iron to be 0.25 pound instead of 0.261 pound per cubic inch, he would have sufficient bulk of clay to allow for shrinkage in drying or baking the clay, and also for shrinkage in the casting. His assumption was only arbitrary, but it happened to work out all right, and that was all that was to be desired.

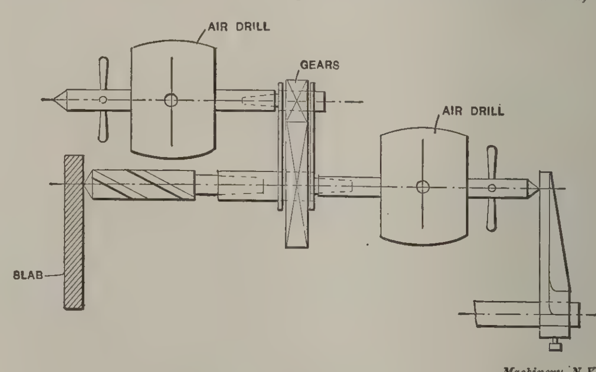
As a consequence, it so happened that before this lad had finished his actual apprenticeship, he was placed in charge of the machine shop. The true genius of the boy was early recognized and to-day Frank holds quite a responsible position as designer.

J. J. Jenkins.

COMPOUNDING AN AIR DRILL.

We had some 2 15-16 holes to drill in an inch-and-a-half slab, and as it was a repair job the work had to be done in place, using an air drill. We started in one Sunday morning with the largest air drill obtainable, which was intended to drill 1½-inch holes at the maximum. And that drill didn't allow the original intentions of its designer to be perverted, either. To begin with, the throttle was out of order, and we could neither start nor stop it except from the valve at the air plug, way across the mill; when the man at the drill and the man at the valve finally got the word together, it started off nicely for a few minutes, until the overload became too great; then there was a short imitation of an automobile going up hill, and silence, with an accompanying lack of rotation on the part of the drill. The boss looked it up and decided it would have to go to the shop for repairs; by the time he got a ratchet and half a dozen "Hunkies" on the job it was 5:30, and we went home.

By the next Sunday (the only day in the week that the mill shut down) we had rigged up two air drills as shown in the sketch, gearing them together; this was done by keying two gears, in the ratio of three to one, on the drill sockets, with a steel plate on each side of the gears to keep the proper center distance and bind the tools together. The main air drill, that



Compounding an Air Drill.

is, the one in line with the drill itself, was held in place by an "old man" and fed in the ordinary way; the other, the upper one in the sketch, was lashed to the first with ropes, twisted tight in order to get the necessary pull. Half-inch holes were first made in the slab with a single drill, and the new apparatus put into commission. After a little experimenting it took hold and put those 2 15-16 holes through just like an up-to-date radial would have done it in the shop.

Of course the full power was not gotten out of the direct-working air drill, as it could not work up to the limit of its speed; but the work was done, and that was all we cared about.

Bessemer.

SCALE OF CHORDS.

The accompanying cut shows a handy and accurate scale for laying out and determining the size of angles. It is made so that in a circle with a radius equal to the distance 0 to 60 on the scale, the distance from 0 is the chord for the equivalent angle. If a is the angle in degrees, the chord $= 2 \sin \frac{a}{2}$, if the radius is considered to be the unit of length. This is the formula by which the scale was constructed. The method of using the scale is as follows:

Take 0—60 as radius and describe an arc; then draw a line from the center to any point on the arc. With a compass set to the proper figure on the scale, and with the point of intersection of the radius with the arc as a center describe another arc which will intersect the first. From the point of intersection draw a line to the center. The angle between the two radii will be the required angle. To find the number of degrees in a given angle draw an arc as described above, using the vertex as a center, and with the scale measure the distance between the two points of intersection, prolonging the sides of the angle if necessary to intersect the arc.

Holyoke, Mass. F. E. PETTERSSON.

[This is a good example of the way old ideas sometimes turn up in new form. The scheme, of course, constitutes a scale of chords, a draftsman's tool which formerly had a much greater use than now when it is largely displaced by the more convenient protractor. The following method for making a scale of chords is copied verbatim from an elementary work on surveying (Davies), published in 1834:

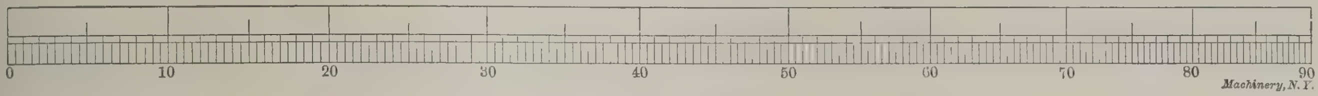


Fig. 1. Scale of Chords.

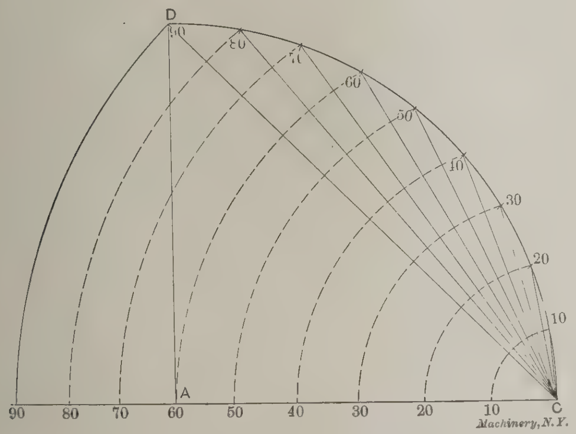


Fig. 2. Laying Out a Scale of Chords.

"If, with any radius, as AC, we describe the quadrant CD, and then divide it into 90 equal parts, each part is called a degree. Through C and each point of division let a chord be drawn, and let the lengths of these chords be accurately laid off on a scale; such a scale is called a *scale of chords*. In the figure the chords are drawn for every 10 degrees."—EDITOR.]

AN ANSWER TO ENTROPY.

Entropy's criticism, in the April issue, of your editorial on "Principles of Rational Design," is very well written and suggestive, but the sentiments he gives voice to remind one strongly of the complaint of the youth who hated to wash his face because it got dirty again so quickly. Because the ideal is unattainable, does Entropy wish us to cease our struggle for it? A near approach to the ideal is not quite so unattainable as he would have us believe. Without doubt the designer referred to in your editorial was thinking principally of machine tools when he spoke, in which the conditions governing design are as well known and as fully recorded, probably, as in any other line of machinery. As a protest against careless designing and slovenly neglect of recorded information, the editorial was timely, as any one having experience with the usual drafting-room methods can testify.

To show that I am not prejudiced in this matter by a tendency to class myself with those ideal designers who can work out a design automatically, by pressing the proper keys and turning the crank, I will relate a little incident that occurred when I was engaged in the design of a certain automatic machine which dealt with materials whose characteristics were unfamiliar to me. The case is, in a way, parallel to that which Entropy mentions.

The machine in question had, as one of its functions, the gluing together of two pieces of cardboard. To apply the glue, the cardboard was carried along tangent to the rim of a narrow wheel or disk, which revolved in a pot of heated glue. The cardboard thus took off from the wheel a band of glue of the required width. This glue, however, acted about as glue might be expected to act under the circumstances. When the card left the wheel the glue did not immediately separate, but strung out into a fine thread or "whisker" as we used to call it. These "whiskers" floated along through the air until they met a cross bar of the machine, where they congregated, and in the course of time formed a full beard as it were, with "side taps" too, if left to themselves too long. The machine was, in fact, continually mussed up and clogged up from end to end with this sticky, semi-solid glue.

We at once began to worry over the problem of preventing this trouble. Finally we hit on a scheme of placing a roller just under the card as it left the wheel and almost touching it. This roller was revolved at a high rate of speed in a direction opposite to that at which the card was traveling, and in a very satisfactory fashion pulled the whiskers out by the roots before they had time to grow to any size. So we solved this difficulty—but were met with another one. How were we to remove from the roll the glue thus wound up upon it? After thinking the matter over without sleep or food for five nights and two days, we hit on the plan of putting a scraper close to the roll, and on this the glue was collected before it had time to freeze solid. Eureka! It worked! The inventor and I shook hands with each other and decided that the question was solved. A freckle-faced apprentice boy who was standing by, however, asked how we were going to get the glue off the scraper. Our crests fell at once, and we retired to meditate on this new problem.

Leaving the inventor and designers with their troubles, let us follow the apprentice for a while. He strayed out to the dump at the back of the shop, selected a properly proportioned and well preserved tomato can, and punched a small hole in its bottom. This he plugged with wood, leaving just room enough for water to come out a drop at a time, semi-occasionally. The boy next hung this over the scraper which collected the glue from the roll, which collected the whiskers from the card, which took the glue from the wheel, which brought it from the glue pot; then he started the machine up. The wheel took the glue up, and applied it to the card, the roll removed the incipient whiskers and transferred them to the scraper, and the water, dropping gently and unostentatiously on the scraper, dissolved the glue as fast as it accumulated and allowed it to drop back again into the pot. And thus was the problem solved. R. E. F.

INSERTED BLADE TURRET TOOLS.

With the advent of high speed steel comes the necessity of making tools with inserted blades, owing to the high price of high speed steel. In the illustrations are shown some of these tools which have been used with great success. In making tools of this description it is always best, except in large sizes, to make them of tool steel, as they have to stand for hard usage. The cost of making is a little more, but is offset by the length of time they will last. Another advantage which is deliberately ignored by many, is in the use of hardened tool steel setscrews for holding the blades. Where a screw has got to be set down hard six or seven times a day something is wanted that will hold. I have seen tools of this kind come

into the shop with casehardened soft steel screws, which would be broken off inside of a week. It's a mighty good man who can drill out a screw and retap the hole in less than half an hour's time, and that half hour would have paid for a tool steel screw which would be good for any number of years. If soft steel screws do not break, they flatten on the end and cause trouble. Tool steel screws up to ⅝ inch

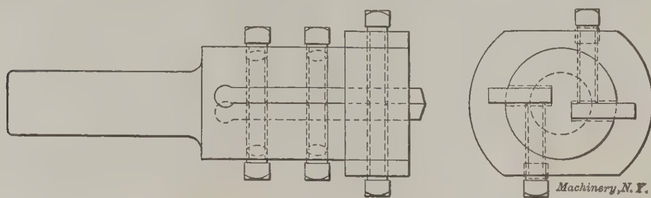


Fig. 1. Inserted Blade Facing Tool.

can be made in the lathe in lots of 50 by an ordinary lathe hand for 12 cents apiece, and those 50 screws are equal to 500 made of soft steel.

Wherever I can use a through bolt instead of a cap screw for holding tool blades I always do so. In that case soft steel has the advantage of being the cheapest, for when a bolt breaks, it can be replaced in two or three minutes. In regard to the tools themselves, Fig. 1 is a squaring tool using flat

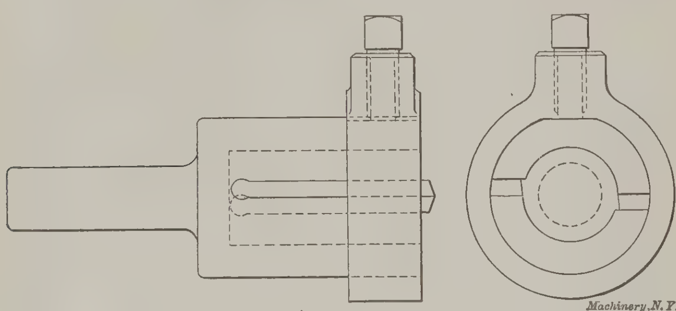


Fig. 2. Inserted Blade Hollow Mill.

stock for blades. Fig. 2 is a hollow mill which will stand up under very coarse feeds. As shown it would only turn the length of the tool body, but in a turret which would take a large shank longer work could be turned by making the shank hollow. Fig. 3 is a combination tool which counterbores, countersinks, and squares the end of the work. Made with a taper shank it can be used to good advantage in the drill press. This tool is somewhat special but the idea can be car-

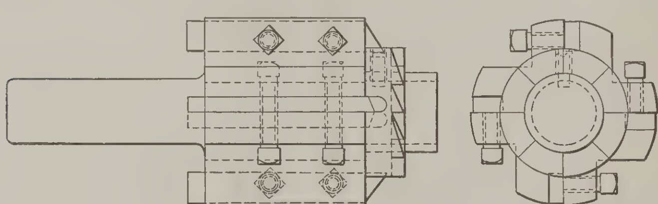


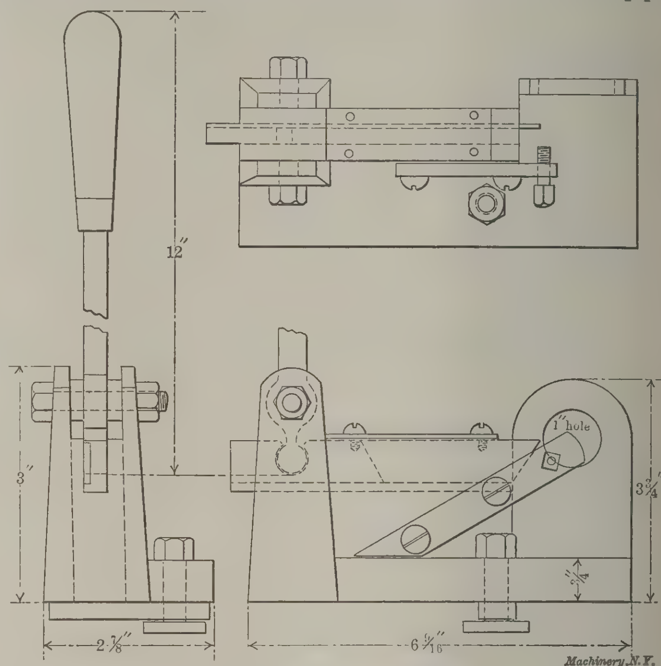
Fig. 3. Combination Counterbore and Countersink with Inserted Blades.

ried out in a great variety of ways. Different sizes of pilots and counterbores can be used, and the blades can be ground to different shapes. PAUL W. ABBOTT.

Lowell, Mass.

DEVICE FOR CUTTING FERRULES.

The cut herewith shows a device I made some time ago for cutting ferrules in the factory where I was superintendent. We used thousands of ferrules cut from 1 inch outside diameter brass pipe. We had tried several different ways to cut them, but they all took too much time, and as these ferrules must be accurate for length, from 5-16 to ¾ inch in length, I finally conceived an idea for making this tool. We had a 13-inch by 7-foot lathe with a 1 1-16-inch hollow spindle, so we bought the pipe in 16-feet lengths, and by using this tool instead of the tool-post, the 1-inch hole being central to the center of the lathe, we were able to cut from 80 to 100 ferrules at one setting. The cut explains itself. By putting the pipe through the hollow spindle and holding it in a universal chuck, it was possible for a boy to cut about 75 to 100 ferrules per minute. It may be seen that by running the end of the pipe in the 1 inch hole which acted as a steady rest, and adjusting the stop screw in the stop bar, all that was necessary was to pull the hand lever which works the cutter bar. The ferrule was cut off and dropped out of the way, and the carriage was run ahead till the setscrew struck the end of the pipe,



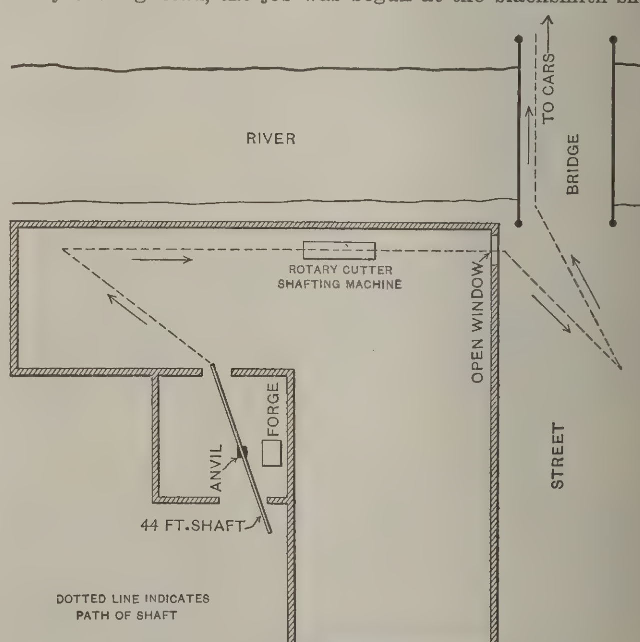
Device for Cutting Off Brass Pipe.

thus setting the tool for another cut. The cutter was made from 1-16-inch self-hardening steel, and by grinding so that the outer edge was a trifle ahead so that it would cut through first, the pipe was cut so that there was practically no burr at all. We also found, when making bushings of different sizes, that this was a very desirable tool. The plant where I am now employed is making a large tool like this for cutting off large shafting, bridge pins, and gas pipe ferrules, etc.

A. L. F.

HANDLING A LONG SHAFT.

Some time ago a New England shop received an order for a 2½-inch shaft, 44 feet long, and free from couplings. As the shop was equipped with a shafting machine having a rotary cutting head, the job was begun at the blacksmith shop



Handling a Long Shaft.

by welding together two 22-foot shafts. The path of the shaft after leaving the anvil will be seen by referring to the diagram. The shaft was run through the open window and into the street after being turned, and was received by twelve men who carried it to the platform cars, two cars being necessary, owing to the excessive length of the shaft. WM. C. TERRY.

Boston, Mass.

ANSWERS TO W. J. B.'S PISTON TROUBLE.

In answer to W. J. B.'s inquiry in the March issue I would say that the trouble might be caused by the method of heating. If the piston was heated through the hole, as the quicker way, the rim would not expand as fast as the center and this would cause the hole to close up. If the rim were heated first, allowing it to expand while the heat worked toward the center there would be no trouble. I have seen holes in rolls for boring mills, bored 2 15/16 inches, heated in the bore, and when cooled off the holes were from 0.002 to 0.003 inch smaller than when first bored. I. J. P.

Referring to the question of W. J. B. in the "How and Why" department of March, I would offer the following explanation The metal surrounding the hole was probably heated to a much higher temperature than the remainder of the piston. The hollow heated metal would expand in the direction of the least resistance or toward the hole, being prevented from expanding in the opposite direction by the resistance of the cooler surrounding portion. I had the same trouble when preparing parts for shrink fits, but the trouble disappeared after allowing the piece to be uniformly heated.

Alliance, Ohio. E. D. Gagnier.

Answering W. J. B.'s inquiry regarding the behavior of a certain 22-inch piston, I would say that the hollow form of piston had nothing whatever to do with the contraction of the hole after heating. Probably the piston was not heated properly, that is, uniformly all over. Heating the piston around the hole only does not enlarge the hole, but rather tends to contract it on account of the high resistance of the cooler metal outside. I would say that the allowance for the fit was about three times too much; 0.002 inch per inch of diameter is the maximum allowance in good practice.

Scottdale, Pa. M. B. Stauffer.

In answer to W. J. B.'s experience with a piston rod not entering the piston after it was heated, would say that I had a similar experience. When working in the Santa Fé Railroad shops about six years ago, I had occasion to fit a piston rod to a piston and made the usual allowance for shrinkage. I informed the roundhouse foreman that the rod was ready to be shrunk in, and he sent some wipers over to the back shop to get the rod and head. In about an hour he came to the back shop roaring like a Kansas cyclone and informed my foreman that I made the rod too tight a fit, for he could not get it in the piston after he had heated it red hot. I maintained that the rod was fitted O. K. and that if I could not put it in, I would eat it. So I went over to the roundhouse, heated the piston evenly all over, laid it on the floor and dropped the rod into place.

After quizzing the roundhouse foreman, I finally got him to admit that he had heated the piston to a cherry red around the hole while the outside was black. Now, in heating the piston more around the hole than on the outside the heated metal expands lengthwise of the hole while the tension of the outer edge tends to close the hole. In heating a piston carefully all over, the expansion is equal in every direction. I have put on a good many pistons and, following the rule of heating evenly, never had a failure yet on either cast iron or hollow steel castings. J. L. Chatham.

Topeka, Kansas.

As I read the inquiry of W. J. B. in which he told of his trouble with a piston I was greatly amused, for I was carried back to an old North Texas contract shop where about eight years ago a thing of the same kind happened.

A machinist was given a piston rod to fit in a piston, and when he had got the rod turned, he heated the piston up to a good red heat around the hole. Then he tried to drive the rod home, but it refused to enter. So putting the piston rod back in the lathe he took a full 64th inch off the fit and again heated it, and then with the aid of a 12-pound sledge he succeeded in driving it into the hole where it seemed to be a very tight fit. But, alas, when the piston cooled off the rod rattled around like a shot in a tin horn. This being a break-down job the piston was wanted at once, and the bad fit caused great confusion among the "office push," as the "nut-splitters" expressed it. It is needless to say that this machinist received his time check at once, which was unjust, but he, belonging to the boomer element, had on his clothes and was out of the town before the real cause was located. I have found in shrinking in work that if the castings are made of dirty iron, such as produced by foundries which use much scrap and stove plate, they will often warp, and bored holes will become oval as soon as they are heated for a shrink fit. Shrinking in a rod is something I never do unless my foreman insists upon it, and then the job is done at his risk, not mine. I always drive the rods in if there is no press available, using a little white lead on the fit. A casting will stand as much, if not more, pressure from a rod driven in with a sledge hammer as from cooling down on a cold piece of steel.

Waco, Texas. Otto P. Downing.

STUD HOLDER FOR BOLT CUTTING MACHINE.

The accompanying cut shows a stud holder intended to hold short studs in a bolt-cutting machine when one end of the stud has already been threaded. Referring to the cut Figs. 1 and 3 show end views and Fig. 2 a sectional view of the device. The body *H* is made of machine steel, and is first drilled crosswise to receive the jaws *J*, shown in Fig. 6. These jaws are made in one piece and fastened in place by the screws *F F*. Then the body with this piece in place is chucked and bored out for the plunger *P*, a detail of which is shown in Fig. 4, and is at the same time bored and threaded for the machine

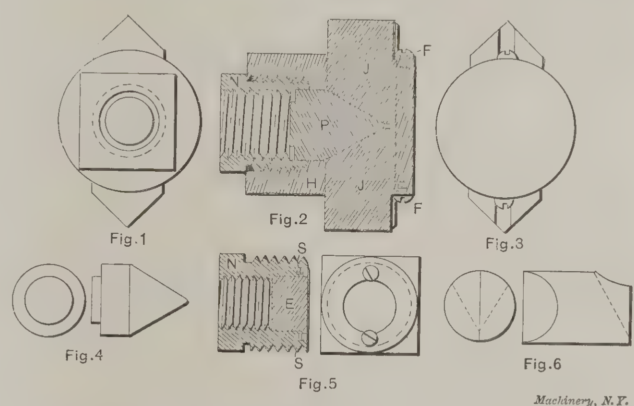


Fig.1 Fig.2 Fig.3 Fig.4 Fig.5 Fig.6

steel bushings *N*. After this is done, the jaws are taken out, cut in two, and the slots for the screws *F F* made a little longer to allow the jaws to freely adjust themselves to the plunger point. The jaws and plunger are made of tool steel and hardened. The square bushings shown can be made of square cold rolled stock and the body of the same kind of round stock, no outside finish being necessary.

The assembled sectional view shows a bushing for 1-inch studs. Fig. 5 shows a bushing for ¾-inch studs. The inside end of the bushing is counterbored for the button *E*, which is a hardened tool steel piece held in place by the two screws *S S*, which prevent it from falling out but allow it to slide in about 1/16 inch the same as the plunger slides in the 1-inch bushing. The threads on the insides of the bushings on all sizes are made the length of the diameter of the stud. The stud to be cut is screwed loosely down against the plunger *P* or the button *E*, as the case may be, and the jaws of the vise tightened up against the jaws of the holder, which in turn force the plunger and, in sizes smaller than 1 inch, the button against the end of the stud, locking it, and also securing the holder in the vise. Opening the vise allows the button, plunger and jaws to go back to their former places, and the stud can be easily removed. M. H. Ball.

Watervliet, N. Y.

* * *

Put not new files on old snags.

Clean wash-ups spoil no dinners.

The $40 tool chest may be that of a 3-cent man.

A stub pencil may write an honest time card.

A file chip in the surface-plate is not worse than a constant borrower.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

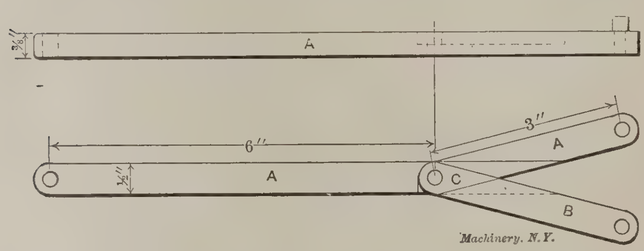
DUPLEX PENCIL FOR RULING PARALLEL LINES.

A convenient draftsman's tool for ruling the two lines with which to determine the correct height of the lettering on a drawing consists of two pencils each with one side planed off and glued together so that the distance between the centers of the leads is the same as the desired height of the lettering. The pencils should be provided with chisel points, care being taken in having both leads extend the same length. This device will rule a double line, giving the proper height of letters, with the same effort required to rule a single line, and save any measuring of the distance between the lines.

Champaign, Ill. E. A. PRITCHARD.

ADJUSTABLE SPANNER WRENCH.

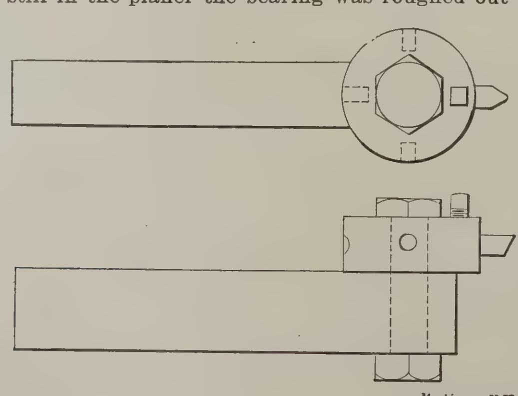
The accompanying cut shows an adjustable spanner wrench which I found of good service. The wrench is for nuts which fit into a recess, and when in place are below the surface. These nuts have holes in the face of them, and as the nuts are of different sizes according to the sizes of the machines they are used for, when the ordinary spanner wrench is used, a different wrench is necessary for each size of nut. In the assembling department the size of wrench needed is usually not at hand, and has to be hunted for, but with a wrench like the one shown in the cut, the hunting (and possibly bad



language) is done away with. As seen from the cut, *A* and *B* are connected at *C*, *B* swinging around a ¼-inch pin as a pivot. The hole at the handle end of the wrench is for hanging it up in a conspicuous place. MACHINIST.

RADIUS PLANING TOOL.

The radius planing kink in the December issue brought to mind a similar job which I ran across some time ago, but one that differed in that a tool held in the tool-post would cut too large a circle. A casting about three feet long was to be grooved to form a half bearing for a journal 2½ inches in diameter, the groove to be parallel to other planed surfaces. While still in the planer the bearing was roughed out to with-

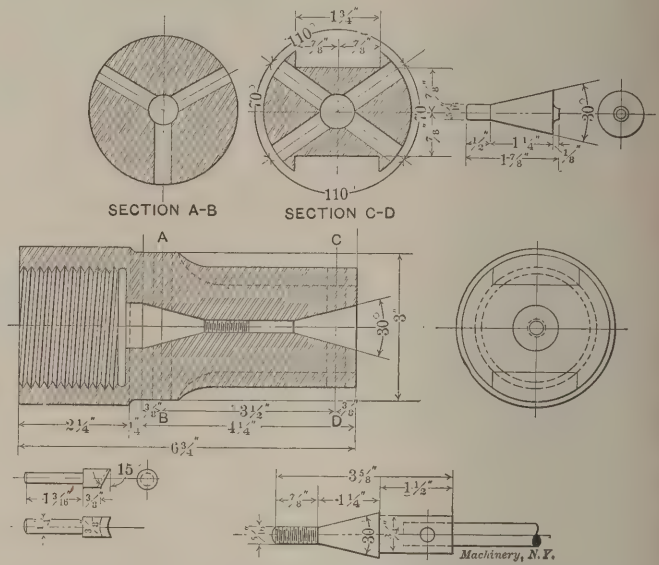


in 1-16 inch of size, and I had the tool shown herewith constructed for finishing. Bolted to the shank so that it could just be turned, was a cast iron head carrying the cutting point. As but one piece was to be machined, feed was given by hand through a long pin wrench inserted in the holes seen in the head, the three holes making it possible to finish the semi-circle with one setting of the tool.

Middletown, N. Y. DONALD A. HAMPSON.

CHUCK FOR AUTOMOBILE ENGINE PISTONS.

The cut herewith shows an expanding chuck intended to hold automobile engine pistons while turning the outside, so that the piston will be held true with the already finished inside bore. The front end of the chuck has a four-point

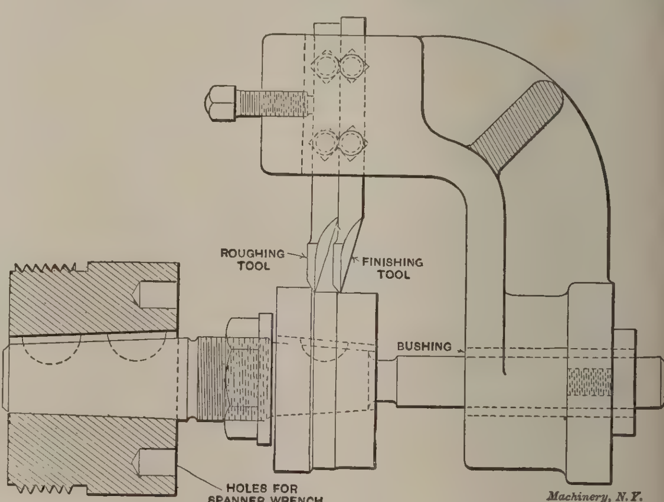


bearing, which is adjusted by a taper plunger forced in by pressing the piston against the end of the plunger. The rear end has a three-point bearing, and the expansion is accomplished by a tapered plunger being screwed in and passing entirely through the spindle. The cut plainly shows the construction of the details. R. H. MITCHELL.

Lansing, Mich.

TURRET TOOLS FOR ROUGHING AND FINISHING PINIONS.

The cut herewith shows a tool which I designed recently for turning and facing pinions on a Warner & Swasey screw machine. It consists of a cast iron overhanging arm carrying a roughing and finishing tool attached in the ordinary way to the turret with two bolts. A cast iron head fitted to the spindle holds the arbor on which the pinion is turned. This arbor is made of tool steel, hardened and ground, and



fitted with Woodruff keys, as shown, to prevent the arbor and pinion from turning on the seat while the cuts are taken. The bushing shown in the arm steadies the arbor during the operation. The hole for the bushing was bored in the machine, bringing it perfectly in line. The tools used are 1 x ½ inch high speed steel cutters. The nut shown is for backing off the pinion after the job is completed. The pinions are first chucked in the same machine, bored, and reamed with a taper reamer. They are then faced on the end with a tool in the cross slide, after which they are put on the fixture shown and turned. Afterward they are faced on the other end to the proper length with a tool in the cross slide.

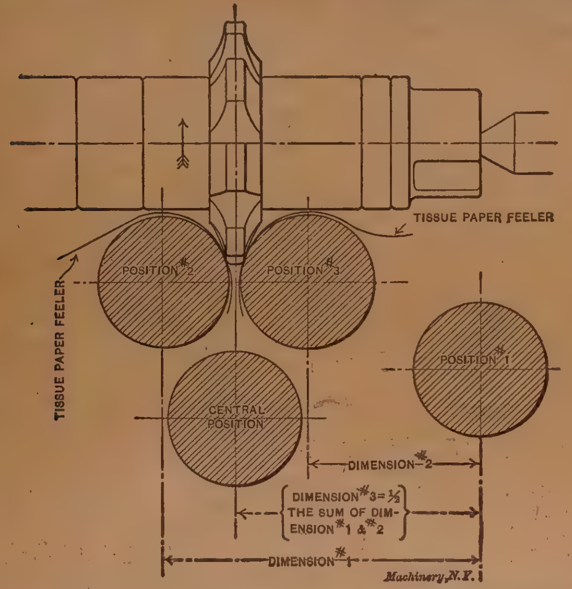
New York City. C. W. PUTNAM.

PUNCH O PUNCH O PUNCH O PUNCH O PUNCH O PUNCH O

These operation sheets, covering every class of shop work, will be made a permanent feature of all Editions, and will appear every month. They may be cut along the top and margin lines for filing and binding. Suitable binders of sufficient capacity to hold four years' issues will be supplied by The Industrial Press for 25 cents each, including postage.

SHOP OPERATION SHEET NO. 1.

Ralph E. Flanders. MACHINERY, May, 1907.



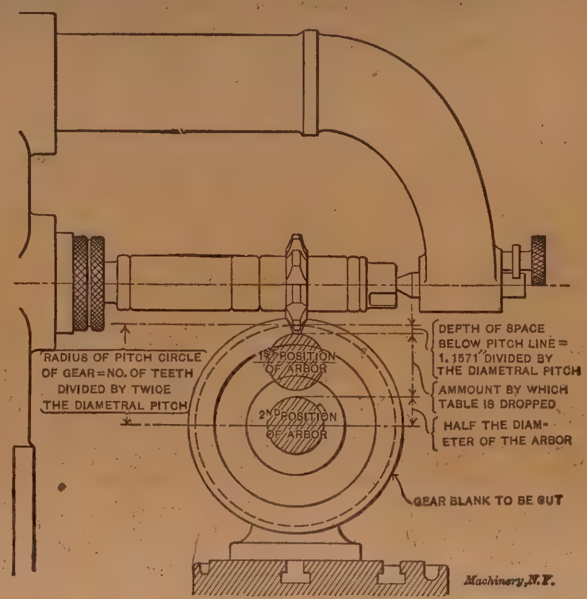
Cutting a 4-Pitch 30-Tooth Spur Gear in the Milling Machine—Centering the Cutter.

1. Clamp a 4-pitch No. 4 cutter on the arbor. Tighten bearings of knee, saddle and table until they move stiffly, but yet evenly. Place a true arbor between the dividing head and foot-stock centers. Bring the arbor to any convenient Position No. 1 as shown in the cut, outside of and below the cutter.
2. Set the graduated dial of the cross-feed screw to zero.
3. Move the arbor to Position No. 2, so that the cutter will just barely "bite" a thin tissue paper "feeler" between its cutting edge and the arbor.
4. Set the elevating screw dial at zero and note on the cross dial the distance moved in changing from Position No. 1 to Position No. 2. Call this amount Dimension No. 1.
5. Lowering the arbor again, return to the Position No. 1 horizontally, the vertical position not being particular. Raise the table until the elevating screw dial marks zero at the same vertical height as Position No. 2. Move the arbor inward until the cutter bites the tissue paper feeler as before. Note on the cross-feed dial the distance by which the arbor is moved horizontally from Position No. 1 to Position No. 3, and call this amount Dimension No. 2, as shown in the sketch.
6. Add together Dimensions No. 1 and No. 2, and divide the sum by 2. The result will be Dimension No. 3, shown in the sketch.
7. Return the arbor to Position No. 1, so far as the horizontal location is concerned; drop it well below the reach of the cutter, and move it in toward the column by an amount equal to dimension No. 3. This is the central position.

Note.—All dial readings must be taken at the end of inward or upward movements, to avoid errors due to backlash.

SHOP OPERATION SHEET NO. 2.

Ralph E. Flanders. MACHINERY, May, 1907.



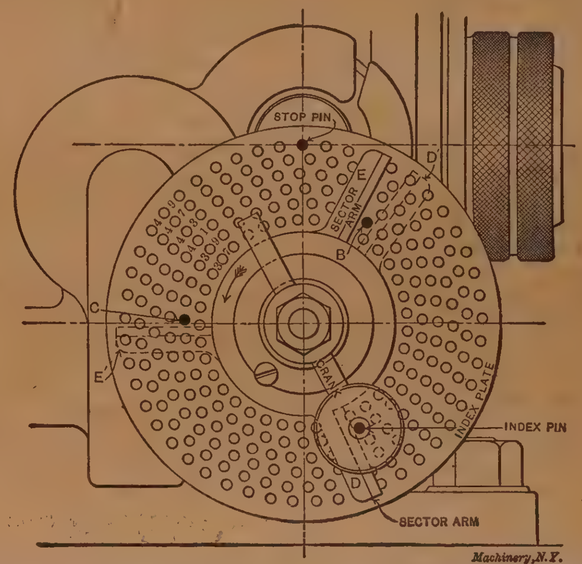
Cutting a 4-Pitch 30-Tooth Spur Gear in the Milling Machine—Setting the Cutter to the Proper Depth.

1. Place a true arbor between the centers.
2. Bring the arbor up to the revolving cutter until tissue paper feeler is "bitten" between the cutter and the arbor.
3. Set the graduated dial for the vertical movement at zero.
4. Divide 1.1571 by the diametral pitch to find the depth of space below the pitch line: $1.1571 \div 4 = 0.2893$ inch.
5. Add to this, half the diameter of the arbor. For a 2-inch arbor we have $2 \div 2 = 1$ inch, and $1 + 0.2893 = 1.2893$ inch.
6. Find the radius of the pitch circle of the gear by dividing the number of teeth by twice the diametral pitch, thus: $30 \div (2 \times 4) = 3.75$ inches.
7. Subtract the distance obtained in Step 5 from that found in Step 6, thus: $3.75 - 1.2893 = 2.4607$ inches.
8. Reading the dial lower the table from the first position the amount found in Step 7. To avoid backlash, lower the table further than is necessary, and bring it up again to the proper position. The machine is now set to cut a tooth of the correct depth.

Note.—If the cutter is too thick, or too thin, or if it runs out, the teeth will be too thick or too thin, as the case may be. But if the blank has the proper outside diameter (found by adding 2 to the number of teeth and dividing by the diametral pitch), the proper thickness of tooth may be gaged by suitable fixed gages, or by the B. & S. gear tooth caliper. If these are not at hand, or if the outside diameter is not accurate, the gear may be tried in place with its mating gear and the fit noted. The setting may then have to be altered from that calculated.

SHOP OPERATION SHEET NO. 3.

Ralph E. Flanders. MACHINERY, May, 1907.



Cutting a 4-Pitch 30-Tooth Spur Gear in the Milling Machine—Indexing.

1. From the table furnished with the machine, find the indexing required. Say that 30 teeth require 1 complete turn and 13 holes more in the 39 circle.
2. Lock the dial with the stop pin, and adjust the index pin to the circle of holes called for in the table—39 in this case.
3. Adjust sector arms *D* and *E* until they include between their beveled edges the number of extra holes required plus one. Here the arms include $13 + 1 = 14$ holes in the 39 circle.
4. Indexing may be done in either direction. Give the crank a portion of a turn to take up the back-lash, and drop the pin in one of the holes. Bring up behind it the beveled edge of the sector arm *D*.
5. Take the required cut.
6. Withdraw the index pin and turn the crank in the direction of the indexing by the number of turns given in the table (one in this case), then continue until the pin enters the last index hole *B* before the second sector arm *E*.
7. Rotate the sector arms until arm *D* has been moved to *D'*, behind the index pin again. Arm *E* is then at *E'* in a position to locate the next stopping point, *C*, for the pin.
8. Take the second cut, and continue the indexing as before.

Note.—It is well to nick the blank before cutting the full depth to make sure that there is no error in the indexing. To do this, touch the edge of the rim with the revolving cutter. Index and repeat in turn for each tooth of the gear. When the starting point is again reached, carefully observe the operation to see if the cutter strikes in exactly the same place. If it does, and if the number of nicks thus made is equal to the number of teeth desired, the indexing is correct.

SHOP RECEIPTS AND FORMULAS.

A DEPARTMENT FOR USEFUL MIXTURES.

This page is intended to be used only for the publication of such shop receipts as the contributors know from experience to be practicable. Receipts are solicited on the condition that the contributors personally know that they are reliable. The fact that a receipt is old and supposedly well-known does not bar it provided it has not already appeared here.

338. CEMENT FOR JOINING METALS TO WOOD.

Dissolve in boiling water 2¼ pounds glue, 2 ounces gum ammoniac and drop by drop 2 ounces of sulphuric acid.

Birmingham, England. W. R. Bowers.

339. CHILLING CAST IRON.

Mix together ½ pint of oil of vitriol, 2 ounces of saltpeter, and 3 gallons of clean water. Heat the casting, and plunge it in this solution, keeping it there until cold.

Dayton, O. George E. Hetzler.

340. CEMENT FOR FASTENING EMERY TO WOOD.

Melt and mix equal parts of shellac, white rosin and carbolic acid in crystals. Add the acid after the other two ingredients are melted. W. R. Bowers.

Birmingham, England.

341. TO POLISH NICKEL PLATE.

Apply rouge with a little fresh lard or lard oil by a piece of buckskin. Rub the bright parts, using as little of the rouge and oil as possible. Wipe off with a clean cloth slightly oiled. Wipe every day and polish as often as necessary. This is also an excellent preventative of rust.

Middletown, N. Y. Donald A. Hampson.

342. TO PREVENT LEAD FROM STICKING TO THE WORK

To prevent lead from sticking to work that has many small corners or grooves, when heated in a lead bath preparatory to hardening, mix lamp black with water or alcohol to the consistency of paint and apply with a brush. Be sure that the mixture is thoroughly dried out before the piece is dipped into the lead bath. E. W. Norton.

343. TO PREVENT THE ACCUMULATION OF FOREIGN SUBSTANCES ON TOP OF A HARDENING BATH.

Dust or small globules of oil, which sometimes give trouble by collecting at the top of hardening solutions, can be disposed of by placing a piece of ordinary newspaper on top of the solution; the dirt and oil adhere to the paper and are thus readily removed, thereby avoiding the labor of skimming the bath. Emil Tschudi.

Cincinnati, Ohio.

344. LIQUID FOR ETCHING ON STEEL.

The following solution will be found excellent and reliable either for very deep etching upon steel, or for the purpose of producing beautiful frosted effects upon the surface. Mix together 1 ounce sulphuric acid, ¼ ounce alum, ½ teaspoonful salt, ¼ pint acetic acid or vinegar, and 20 drops concentrated nitric acid. The etching effect produced by this solution depends upon the length of time it is allowed to act upon the metal. It is applied in the same way as ordinary etching acid. T. E. O'Donnell.

Urbana, Ill.

345. TO BLACKEN BRASS.

Should it be desired to change the color of an article made of brass to a dark bronze or black, the following compound will be found to give good results, especially if the metal has a polished surface. First make up a solution of 120 grains of nitrate of silver and 5 ounces of water; then dissolve 120 grains of copper nitrate in 5 ounces of water. Mix the two solutions together in equal parts, making a quantity sufficient to immerse the articles in. Clean the brass articles to be blackened thoroughly in hot soda water, and then dip in the above compound. Remove and heat in an oven until the proper shade of color appears. T. E. O'Donnell.

Urbana, Ill.

346. CEMENT FOR FASTENING LEATHER TO IRON.

To make a good quality of glue for fastening leather to iron, as required when covering iron pulleys with leather, etc., the following will be found to be a good receipt: To one part of glue dissolved in strong cider vinegar add 1 ounce of Venice turpentine. Allow this to boil very slowly over a moderate fire for 10 or 12 hours. It should be applied to the surface of the iron, upon which the leather is to be cemented, with a brush, while it is still quite warm. Before applying, the iron surface and the leather should be scraped perfectly clean. Then put on the leather, press it firmly into place and allow to dry for a few hours. T. E. O'Donnell.

Urbana, Ill.

347. CEMENT FOR LOCOMOTIVE FRONT-ENDS.

A cement that was commonly used on the Fallbrook R. R. locomotive front-ends some years ago to stop all cracks and leaks, was composed of litharge mixed with sufficient boiled linseed oil to make a stiff paste. Into this paste was thoroughly mixed about one-third bulk of old rope cut into short lengths—about one inch—and separated into its constituent fibers. This cement hardens like iron and the rope fibers hold it together while drying and also prevent squeezing out when the front-end casting is bolted to the smokebox. This cement will be found useful in many other places where it will be subjected to heat. M. E. Canek.

348. FIREPROOFING SOLUTION FOR TOOLMAKERS' APRONS, ETC.

Toolmakers' aprons, factory shades and other inflammable materials may be rendered absolutely fireproof by being treated with the following solution: To ½ pound tungstate of soda add 2 quarts of water, or enough to entirely dissolve it, and bottle up tightly. This stock solution is to be added to sufficient water required to soak the article in the proportion of one-fifth the above solution to the required water. After being soaked, hang the article up to dry. Fireproofing factory shades at windows near gas jets or the cloth aprons worn when working over a fire in hardening and tempering tools, etc., will often save bad fires or serious accidents.

E. W. Norton.

349. TO GIVE IRON A BLACK COLOR.

To give iron a dead black color, clean all grease and dirt from the metal, and apply the following solution either with a brush or by dipping. Mix together thoroughly 1 part bismuth chloride, 2 parts mercuric bichloride, 1 part copper chloride, 6 parts hydrochloric acid, 5 parts alcohol and 52 parts water. As soon as these parts are thoroughly mixed, the compound is ready for use. After applying the compound, the iron is placed in boiling water and let remain there for one-half hour, the water being kept at the same temperature. Repeat this operation until the color is deep enough, then fix the color by placing the iron for a short time in a bath of boiling oil. After removing, heat in an oven until the surplus oil is all driven off. T. E. O'Donnell.

Urbana, Ill.

350. ETCHING ON COPPER.

For acid resisting ground use a mixture of 2 ounces white wax to which when melted is added 1 ounce gum mastic in powdered form, a little at a time, until the wax and gum are well mixed. Then, in the same way, add 1 ounce powdered bitumen. When this is thoroughly mixed add to it ½ of its volume of essential oil of lavender. This should be well mixed and allowed to cool. The paste can be applied with a hand roller, and if it is too thick, can be made to flow easier by adding a little more oil. When the paste is applied to the copper plate, expose it to a gentle heat in order to expel the oil of lavender. For a biting or etching acid use a mixture of 5 parts of hydrochloric acid, 1 part of chlorate of potash and 44 parts of water. The water is heated and the potash added. The acid is added first when the potash is fully dissolved. This mixture is used by immersing the whole object to be etched, the object, of course, first being covered on all sides by the acid resisting ground.

Dayton, O. Oliver E. Voris.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

C. H. T. Having given a rectangular hopper with the angles a and b of the slope sheets known, produce a general formula in terms of the angles a and b for finding the angle between the intersecting sheets. In other words, give a formula for finding the angle to which the connections between the slope sheets must be bent in order to fit exactly in place.

We have been unable to derive a direct formula for doing this in a single operation. It can easily be done, however, in two operations. Fig. 1 shows three views in third angle projection of an irregular rectangular hopper for which it is desired to find the value of the diedral angle AD. The important measurement points in this figure are designated by letters. In cases where in a given view these points are one

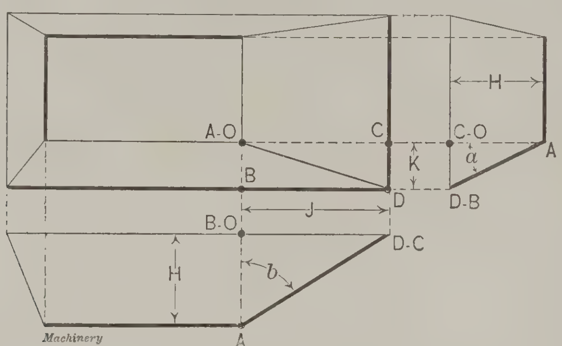


Fig. 1. Diagram of Hopper.

directly behind the other, both letters are used at the same point—as, for instance, at BO in the lower view. O, as may be seen from the other views, being an imaginary point at the intersection of the vertical line AO with the plane of the top of the hopper, while B is a point in the outer rim. We will give the solution in terms of the tangents of angles a and b. It will be readily seen that tangent $a = \frac{K}{H}$ and that tangent $b = \frac{J}{H}$. Fig. 2 is the diagram we will use in deriving our formulas. Similar letters here refer to similar parts of Fig. 1. In addition to the lines of Fig. 1, OD is drawn, and EF at right angles to it. OG is drawn at right angles to AD. Being in plane AOD, OG is likewise at right angles to EF. Lines

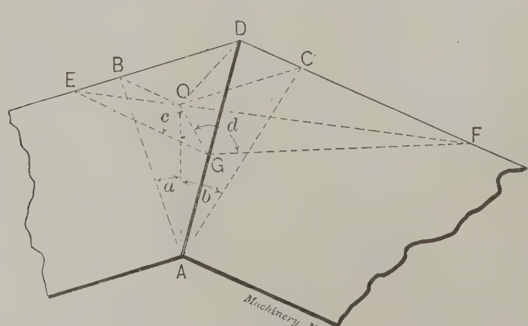


Fig. 2. Solution of Hopper Problem.

EG and FG are also drawn. The angle we are seeking is $\angle EGF$. It is composed of $\angle EGO$ and $\angle OGF$, which we will call c and d respectively. Bearing in mind that Fig. 2 is drawn to an angular projection, so that the angles do not show in their true value, we will proceed to use it in obtaining our formulas.

We see by inspection that, as before stated,

$$\angle EGF = \angle c + \angle d \qquad (1)$$

Further inspection shows that

$$\tan.\ c = \frac{EO}{GO} \qquad (2)$$

Since triangles EOD and OBD are both right angle triangles with a common angle at D, they are similar, therefore

$$\frac{EO}{DO} = \frac{BO}{BD} \qquad (3)$$

Proceeding, and noting that $BD = CO$ we have

$$EO = \frac{DO \times BO}{BD} = \frac{DO \times BO}{CO} \qquad (4)$$

Since triangles OGA and DOA are both right angle triangles with a common angle at A, we may say that

$$\frac{GO}{AG} = \frac{DO}{AO} \qquad (5)$$

Since we will deal here entirely with angles, and not with linear measurements, we will take line AO as our measure, giving it a value of unity. Remembering this we may transform equation 5 as follows:

$$GO = \frac{AG \times DO}{AO} = AG \times DO \qquad (6)$$

Since OG is a perpendicular erected on the hypotenuse of the right angle triangle AOD, and again remembering that $AO = 1$ we have

$$AG \times AD = \overline{AO}^2 = 1 \qquad (7)$$

Since AD is the hypotenuse of the right angle triangle AOD, we have

$$\sqrt{\overline{AO}^2 + \overline{DO}^2} = AD. \qquad (8)$$

Since DO is the diagonal of rectangle $BDCO$ we know that

$$\overline{DO}^2 = \overline{BO}^2 + \overline{CO}^2 \qquad (9)$$

Substituting in equation 8 this value of $\overline{DO}^2$ and replacing $\overline{AO}^2$ with 1, we have

$$AD = \sqrt{1 + \overline{BO}^2 + \overline{CO}^2} \qquad (10)$$

Substituting this value of AD in equation 7 we have

$$AG \times \sqrt{1 + \overline{BO}^2 + \overline{CO}^2} = 1 \qquad (11)$$

Transposing this gives us

$$AG = \frac{1}{\sqrt{1 + \overline{BO}^2 + \overline{CO}^2}} \qquad (12)$$

Substituting this value of AG in equation 6 we have

$$GO = \frac{DO}{\sqrt{1 + \overline{BO}^2 + \overline{CO}^2}} \qquad (13)$$

Now in equation 2 substitute the value of EO as found in equation 4; and of GO as found in equation 13; this gives us

$$\tan c = \frac{DO \times BO}{CO} \times \frac{\sqrt{1 + \overline{BO}^2 + \overline{CO}^2}}{DO}$$

$$= \frac{BO}{CO} \sqrt{1 + \overline{BO}^2 + \overline{CO}^2} \qquad (14)$$

Remembering that AO is taken as unity, an inspection of Fig. 2 shows us that BO is the tangent of angle a, and that CO is the tangent of angle b. Changing equation 14, then, to agree with this, we have

$$\tan c = \frac{\tan a}{\tan b} \sqrt{1 + \tan^2 a + \tan^2 b} \qquad (15)$$

In a similar way we may prove that

$$\tan d = \frac{\tan b}{\tan a} \sqrt{1 + \tan^2 a + \tan^2 b} \qquad (16)$$

Having found by these formulas $\angle c$ and $\angle d$, they may be added together as per equation 1 to give the value of the required angle at EGF.

A. W. H. I am building a stationary vertical four-cycle gas engine, 4½ inches bore, 7½ inches stroke. Please state how many cubic inches of clearance space should be allowed for, to get 95 pounds per square inch compression? Of what diameter and weight should the flywheel be for 360 revolutions per minute? How long should the connecting rod be between

centers? What diameter shall I make the exhaust valve opening? What horsepower would the engine develop?

A. A good formula for the compression in a gas engine cylinder is

$$P \times V^{1.3} = \text{constant}$$

In our case, considering the entire volume with the piston at the extreme outer travel as being equal to unity, this becomes

$$P \times V^{1.3} = 1$$

You do not state whether the 95 pounds compression required is absolute or gage pressure. We will consider, however, that it is absolute pressure, which is 15 pounds more than gage pressure; 95 pounds gage pressure, or 110 pounds absolute pressure, would be a rather higher compression than is commonly used on so small an engine. Substituting this value for V in the equation we have

$$95V^{1.3} = 1$$

Solving this equation (you will have to use logarithms to do this) we have

$$V = 0.241$$

which is the percentage of the total volume required by the clearance. The percentage of the total area swept by the piston $= 1.0 - 0.241 = 0.759$. This volume is 119.25 cubic inches according to your figures, so that the total volume of the cylinder equals $119.25 \div 0.759 = 157.11$ cubic inches. Since 119.25 cubic inches of this is swept by the piston the clearance is $157.11 - 119.25 = 37.86$ cubic inches.

With 95 pounds absolute compression, using ordinary coal gas and with a clearance space of the size given, about 70 pounds mean effective pressure can be expected. Using this value for the mean effective pressure in the well-known horsepower formula, we have

$$\frac{PLAN}{33{,}000} = \text{H. P., we have}$$

$$\frac{70 \times \frac{7.5}{12} \times 15.9 \times 175}{33{,}000} = 3.7\text{, or, say, } 3\tfrac{1}{2} \text{ horsepower.}$$

The connecting rod may be about $2\frac{1}{2} \times$ the length of the stroke, or a little more. This brings it about 19 or 20 inches long.

The following formula may be used for the diameter of exhaust valve opening:

$d = 0.00572\, D \sqrt{RL}$,

D = diameter of the cylinder in inches,

R = revolution per minute of the crankshaft,

L = length of stroke in inches.

Solving this equation we have $D = 0.00572 \times 4.5 \sqrt{350 \times 7.5} = 1.319$ inch, or say $1\frac{3}{8}$ inch diameter for exhaust valve opening. The inlet valve can be slightly smaller, about $1\frac{1}{8}$ inch perhaps.

There is no hard and fast rule as to the diameter of the flywheel. This can be made of any convenient size, always remembering, however, that the peripheral velocity should not be more than 3,500 feet per minute. Let us suppose that an outside diameter of 30 inches can be used easily. In order to get the weight of the rim, we will have to find out what percentage of variation in speed we can allow. Since our gas engine receives an impulse every second revolution and sometimes not as often as that (if it is governed on the hit-and-miss principle) it tends to slow down after each charge is exploded, until the next charge is fired. For ordinary work a coefficient of speed variation of 0.05 may be allowed. This would be too high for a dynamo intended for electric lighting and would be very much smaller than would be necessary for a launch engine, but it may be taken as a good average for such work as driving machine tools, pumps, woodworking machinery, etc. This 0.05 variation in this case signifies that the speed may vary between 341 and 359 revolutions. The following formula may be used for finding the weight of the flywheel:

$$W = \frac{\text{I.H.P.} \times 111{,}600{,}000{,}000}{f^2 N^3 E}$$

in which I.H.P. = indicated horsepower,

f = the diameter of the flywheel at the center of gravity of the rim in inches (in this case roughly estimated to be two inches less than the outside diameter),

N = revolutions per minute of the crankshaft,

E = coefficient of unsteadiness permitted.

The indicated horsepower will be slightly greater than the 3.5 brake horsepower we have calculated for the engine. We may call it 4. Our formula now reads

$$W = \frac{4 \times 111{,}600{,}000{,}000}{28^2 \times 350^3 \times 0.05} = 260 \text{ pounds,}$$

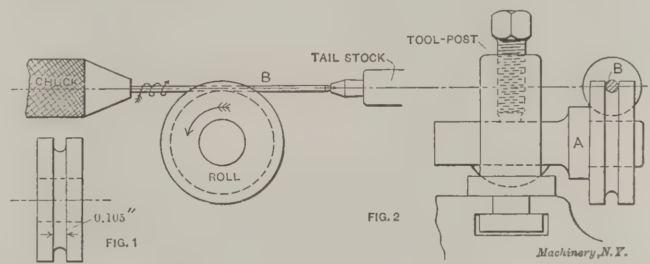
which is the required weight for the rim of the wheel.

For a more extended treatment of the design of gas engines we would refer you to "Gas Engine Handbook," by E. W. Roberts, published by The Gas Engine Publishing Co., Cincinnati, and "Elements of Gas Engine Design," by Sanford A. Moss, published by D. Van Nostrand Co., New York.

Jeweler. I would appreciate some information enabling me to lap jewelers' rolls such as shown in Fig. 1. The groove in these rolls has to be very exact and smooth, as they are used for rolling gold filled stock which cannot be finished afterward except by buffing.

Answered by Frank E. Shailor, Great Barrington, Mass.

A. To satisfactorily lap the slot in a roll such as shown in Fig. 1, I would suggest the following method, fully illustrated in Fig. 2. When machining the slot, care should be exercised in making the slot as smooth as possible before hardening as this will lessen the amount of lapping. After hardening



Figs. 1 and 2. Lapping Jewelers' Rolls.

the roll, take a piece of soft steel rod (in this case 0.105 inch diameter) and secure it in a lathe chuck. The outer end should be pointed to run in a female center. A piece of steel is now made to fit the tool-post of the lathe, and one end is turned to fit the hole in the roll. The roll is placed on the stud A, and the carriage of the lathe is moved so that the groove in the roll will come directly under the rod B. Smear the rod with flour emery paste, and cause the rod to rotate rapidly by power, and by hand slowly revolve the roll. It will be seen that lapping in this manner will finish the sides of the slot as well as the radius at the bottom. Rig up so that the roll can be moved along on the rod occasionally to compensate for the wear of the rod. When the slot is cut in the soft roll, there will be minute ridges left in the slot, and it is better to have the lap rotate crosswise of the ridges, for if a formed lap is made and caused to rotate in the same line of travel as the slot, the ridges in the roll will spoil the truth of the lap before they are entirely removed from the slot. For high polish after having smoothed the slot, rotate the rod very rapidly using very little emery.

* * *

An advisory committee of the editors of the principal technical papers in New York City has been organized to cooperate with the American Institute of Social Service in the work of protecting life and limb. At the present time the committee consists of representatives of the *Scientific American*, *Iron Age*, *Railway and Locomotive Engineering*, *Automobile*, *Electrical World*, *Street Railway Journal*, *Dry Goods Economist*, *Electrical Age*, MACHINERY, *Railway Gazette*, *Engineering and Mining Journal*, *Engineering News*, *Engineering Magazine*, *American Machinist*, *Power*, *Electro-Chemical and Metallurgical Industry*, *Electrical Record*, *Engineering Record*, *Insurance Engineering*, and *Architectural Record*, all of New York. A meeting of the committee was held at the Aldine Club, April 11, to fix the conditions of competition for the three gold medals that have been offered.

NEW MACHINERY AND TOOLS.

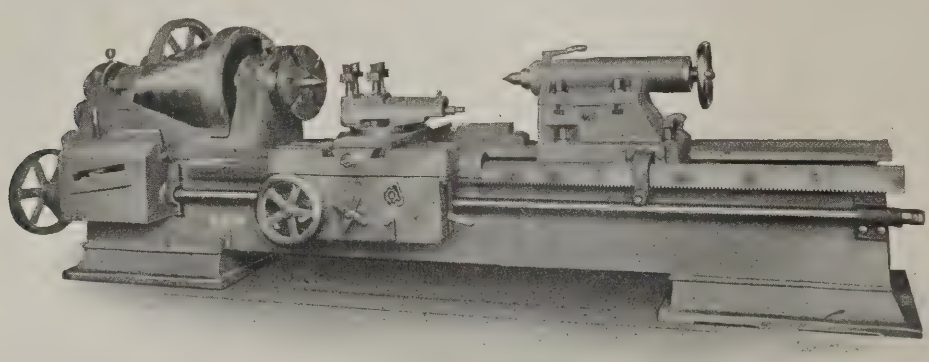
A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

THE NEW HAVEN HEAVY 32-INCH ENGINE LATHE.

The lathe shown in the cut is one of a line of heavy tools which the New Haven Mfg. Co. of New Haven, Conn., has built to meet the demands of modern tool steel, and modern rates of production.

The spindle has a 2 11-16-inch hole through its length, and has a front bearing 5¾ inches in diameter by 9½ inches long. The front and back bearings are split taper boxes of a special bronze metal, and are adjustable by being drawn into the head by means of square threaded nuts at either end. With this style of box it is easy to keep the bearings in proper adjustment without disturbing the alignment of the spindle. The thrust is taken on alternate bronze and tool steel rings hardened and ground. The thrust adjustment is entirely at the back end of the headstock so that the effect of expansion on the length of the spindle is not felt. With a single speed countershaft, ten spindle speeds in geometrical progression are obtained, ranging from 3 to 350 revolutions per minute. When working at its maximum power the 4½-inch belt of the back-geared head machine runs at 86 feet per minute, the back gear ratio being 15 to 1. The lathe may be furnished, if desired, in the triple geared design, in which case the maximum speed of the 5½-inch belt used is 240 feet per minute.

The feed changes are obtained through a rapid-change gear device of the design illustrated and described in our issue of August, 1904. The various levers are so interlocked as to prevent all possibility of damage from careless handling of the device. A special feature of this gear box is the provision



New Haven 32-inch Engine Lathe.

made for connecting the lead screw directly to the driving gear shaft by a positive clutch. When this is done, ordinary change gears may be used in the usual manner for cutting special threads, as if there were no change gear device incorporated in the machine. In addition to the usual range of threads, spirals of from one turn in 1 inch to one turn in 12 inches may be cut by throwing in the back gears, the threading mechanism being so arranged that it can be connected under these conditions to the back gears instead of to the spindle, if desired.

The apron is of the double-wall, box form, bevel gear driven from the splined lead screw, and powerfully geared throughout. The cross and longitudinal feeds interlock with the lead screw nut in such a way as to prevent one of them from being thrown in simultaneously with the others. Both feeds are controlled by a friction drive, and the hand wheel pinion may be disengaged when cutting threads. A rigid and compact taper attachment is fastened to the rear of the carriage in such a fashion as to control the compound rest without interfering with the use of the cross feed screw for adjusting the tool. It will turn tapers up to 4 inches per foot and 24 inches long, and is graduated both in inches per foot and in degrees. The compound rest has a power feed in all directions, and is graduated in degrees. The cross feed screws are also graduated. The tailstock has a pawl engaging a rack cast solid in the bed, which makes slipping under heavy duty impossible. This 32-inch swing lathe can be furnished with beds of even lengths from 14 to 36 feet.

SPRING COLLET ATTACHMENT FOR LATHE.

The Adjustable Collet Co. is a recently organized firm located at 224 High Ave., Cleveland. It is placing on the

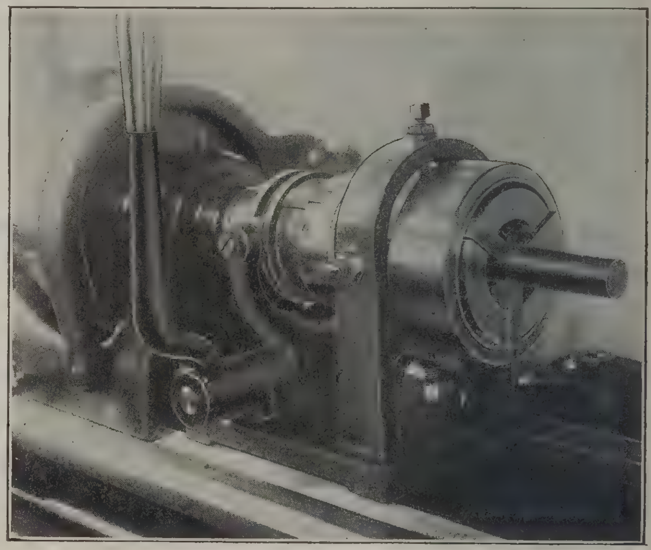


Fig. 1. Automatic Collet Attachment Operating on Bar Stock.

market a convenient attachment for giving to an ordinary lathe some of the advantages of the screw machine—so far, at least, as the work holding features are concerned. The device is illustrated in the three accompanying halftones.

The rear end of the spindle of the device is screwed to the threaded nose of the lathe spindle. The front end is carried in a bronze taper bearing, adjustably supported by the casting which forms the frame of the attachment. The adjustment allows both vertical and horizontal shifting of the bushing by means of setscrews and check nuts, to bring the outer end of the supplementary work spindle accurately to alignment with the axis of the lathe.

In the form of chuck shown in Fig. 1, three jaws are used to grasp the stock. These jaws move radially with a direct

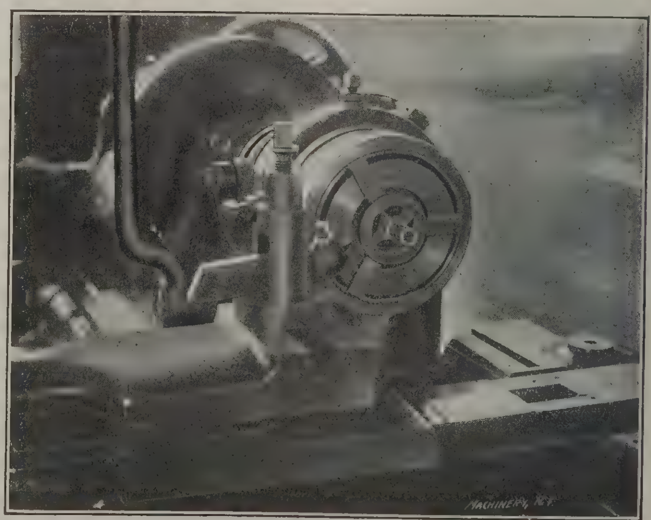


Fig. 2. Attachment arranged with Step Jaws for holding Castings, Disks, Etc.

thrust, and bear on stock of different diameter for their full length, gripping all sizes in fractions within their capacity. In this design the draw-in principle is used. The jaws are

closed by the action of a sliding cone of the usual type at the rear of the supplementary spindle. This cone, actuated by the hand lever shown, opens the chuck levers, draws the chuck jaws into the taper, and thus closes them on the stock. Adjustment for size is obtained in the usual manner by screwing in or out the threaded bushing which backs the chuck levers.

In Fig. 2 the attachment is shown adjusted for large diameter, and a casting is shown in place in the jaws. Various forms of these jaws may be provided for work of different

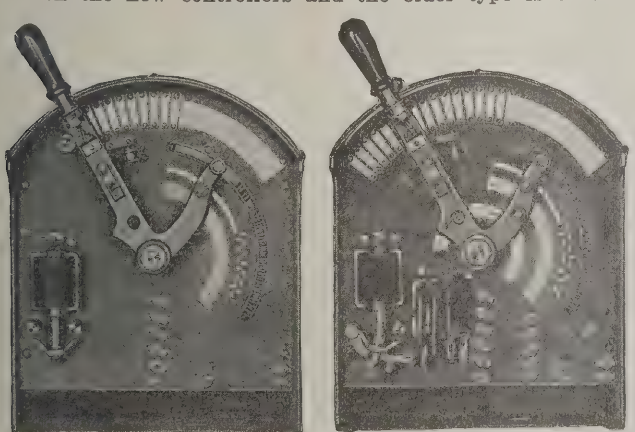
Fig. 3. Details of Spring Collet Attachment.

kinds, the stepped form being a very useful one for castings and disks. This chuck may also be made in the four-jawed form, when it is able to handle square stock. A further variation of the device is shown in Fig. 3, where the "push" form of action has been used. Plain jaws of large capacity are shown in place in the collet while stepped jaws are shown disassembled.

This attachment is made for any size or make of Fox, speed, or engine lathe, or for plain head turret machines—in a word, for any lathe not having an automatic chuck. The portable base of the attachment allows a sufficient vertical adjustment to adapt the attachment to lathes of varying makes and sizes. The attachment does away with the necessity for separate collets for each size of bar stock, or for false bushings. They are made, as before mentioned, in push or draw form, either with three or four jaws, the four-jaw collet being used on square or octagon stock and the three-jaw for round or hexagonal stock.

IMPROVED CUTLER-HAMMER CONTROLLER FOR MACHINE TOOLS.

The Cutler-Hammer Mfg. Co. of Milwaukee has recently placed on the market a new line of printing press and machine tool controllers. These controllers are of the well-known Carpenter type, and embody the distinctive features of this class of Cutler-Hammer apparatus. The essential difference between the new controllers and the older type is that the



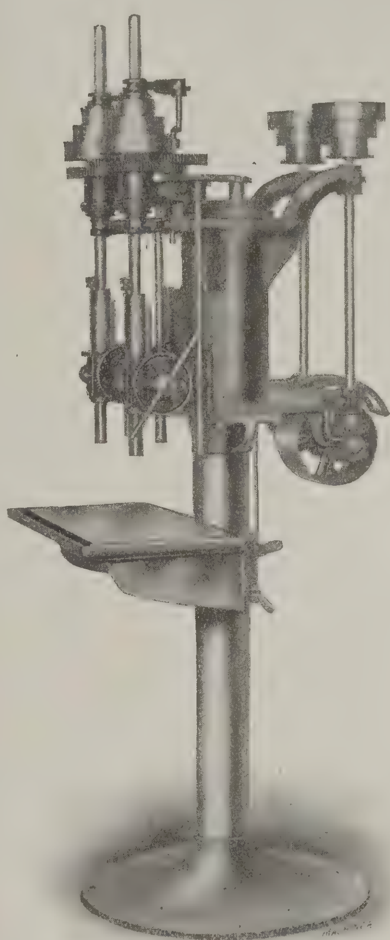
Non-reversible and Reversible Cutler-Hammer Controllers for Machine Tools.

former provide for a greater number of field speeds than the latter.

At the time the first "Carpenter" printing press and machine tool controllers were placed on the market it was the accepted practice to obtain the major portion of speed variation by means of armature resistance, the increase in speed secured by means of field control seldom exceeding 15 per cent. Of late, however, variable speed motors, so designed as to permit of their speed being increased as much as 400 per cent by field control, have come into use, and the present line of controllers has been designed to meet this new condition in printing press and machine tool work.

Like the older type of apparatus, the new line of controllers is provided with an auxiliary breaking device equipped with a powerful magnetic blow-out. In opening the circuit by moving the lever to the "off" position, the break does not occur on the contacts, but on an auxiliary device located just below the contact segments. This prevents arcing on the contacts. The contact segments themselves are of hard-drawn copper and are separately renewable.

The controllers are equipped with cast iron covers which completely enclose all of the apparatus except the handle of the operating lever. All contact parts are removable from the slate front without disturbing the interior connections, and all terminals are labeled with brass tags, insuring proper wiring.



Reed Two-spindle Drill.

In this new line of controllers the speed regulation is effected by means of both armature and field resistance, the armature resistance being furnished separately, though it is possible to mount it with the front if desired. The field resistance is, in all cases, attached directly to the front of the controller, and provision is made for positively holding the lever on any desired contact.

Six distinct pieces of apparatus are comprised in this latest line of printing press and machine tool controllers—three non-reversible and three reversible. In each class the controller may be had with underload release only, with underload and overload release, and with underload, overload and push-button release and dynamic brake.

The new apparatus is described in Cutler-Hammer bulletins Nos. 81½, 82½, 83½, 84½, 85½ and 86½.

REED TWO-SPINDLE DRILL.

The Francis Reed Co. of Worcester, Mass., is building the new drill press shown in the accompanying half-tone. The machine is designed to fill in the gap between the sensitive drill press and the lighter styles of back gear drill, and at the same time retain as many of the valuable features of both as possible.

The independent style of drive used by the builders on their regular line of drills is retained. The countershaft is combined with the machine, and drives the vertical back shafts through bevel gears, one of the pair being rawhide, which makes it a very quiet running machine. The spindles are driven by three-step cones, using open belts 1½ inch wide. The spindles have a 1-inch bearing through the quill, which will allow a feed of 6 inches. This, added to the 4-inch adjustment permitted by the sliding bracket, gives a movement of over 10 inches without moving the table. When the back gears are thrown in, the drive gives a reduction of about

7 to 1, and is powerful enough to drill holes up to 1 7-16 inch in diameter. Without the back gears, the machine is capable of doing the delicate work of a sensitive drill. The back gears are entirely disengaged when thrown out, and are easily brought into gear and locked in position by the movement of a single lever. They are very easily handled, change from a light sensitive drill to a back-geared machine being made in a moment's time. Since the spindles are independent of each other, one may be used with the back gears and the other without, when the nature of the work demands it.

Special attention is called to the feed, which may be furnished with this machine when desired. It has three speeds, giving movements of 0.009, 0.011, and 0.014 inch, respectively, per turn of the spindle. With the countershaft running at 450 revolutions per minute, the mechanism will feed 10 inches per minute with the speed and feed in their fastest positions. The feed is independent for each spindle and derives its power from that spindle, so that the movement will stop if the driving belt for a spindle slips or breaks, thus saving breakage of drills.

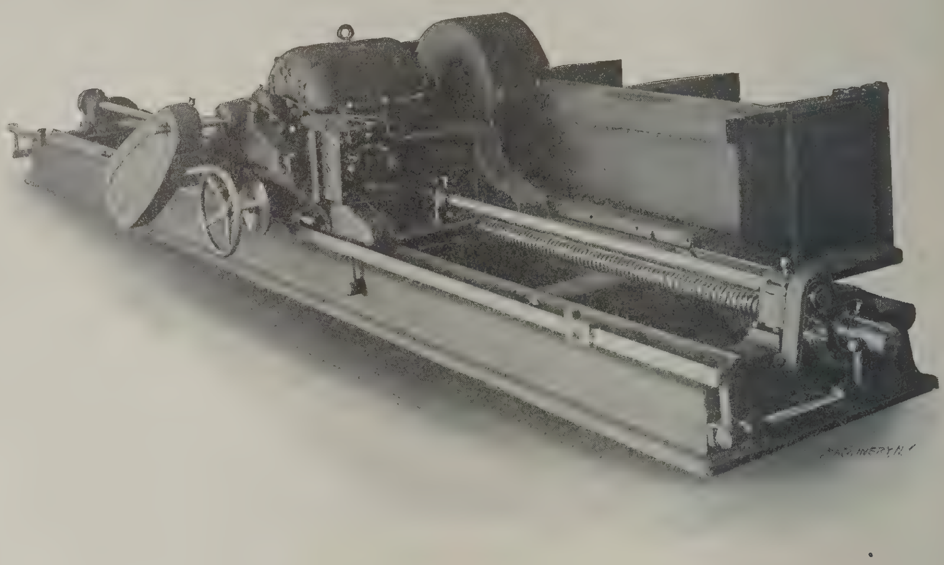
The table will move up or down or swing clear around if necessary. It is counterweighted, so that the workman may easily adjust it if it is not too heavily loaded. The drill has a swing of 16 inches.

NEWTON CHORD BORING MACHINE.

In boring chords and other members of bridge and structural steel work, the vertical position of the boring bar is the most suitable arrangement. The work being often of considerable size and weight, it is advisable, as well, to bore the holes at each end at the same time whenever possible. The machine shown in the accompanying half-tone, built by the Newton Machine Tool Works, Inc., Philadelphia, Pa., is built to meet the requirements of work of this kind.

Newton Chord Boring Machine.

The machine is composed, as shown, of two uprights and two central supporting pieces. These are intended to be fitted to a long base made up of I-beams, on which the uprights will be adjustable to give different center distances, the adjustment being made by a vertical pinion through bevel gears, as shown. Besides the small intermediate supports for the work, the machine may be made with adjustable work tables if desired. A hole is bored in the work table for a lower support to the boring bar.



Motor-driven Edge Grinder.

The spindle is 4 inches in diameter, and has a 32-inch continuous automatic feed, with four geared changes and a rapid hand adjustment. The spindle is driven by a phosphor bronze worm-wheel through back gears, and in the arrangement shown in the cut an alternating-current motor is used, which is connected to the driving shaft by a pair of cones and a belt. The distance from the center of the spindle to the upright is 30 inches. The distance from the end of the spindle to the work table is 42 inches. The work table is 36 inches square.

MOTOR-DRIVEN EDGE GRINDER.

The illustration shows a large motor-driven edge grinder, adapted to handle work up to 160 inches long. It was designed primarily to grind the edges of heavy laminated safe plates, but is well adapted to do other work of this kind.

The wheel carriage slides on one V-way, 5 inches wide, and one flat way, 6 inches wide, with a bearing on the ways, 60 inches long. The working part of the platen is 15 inches by 160 inches, but five projections 30 inches long each are provided to support extra wide plates, etc. The machine is driven by a 12½ H.P. direct current Robbins & Myers motor, which operates both the grinding wheel and the travel of the carriage.

The carriage is driven from one end of the motor spindle by means of a Morse silent chain, which connects it to a splined shaft by bevel gears, which, in turn, alternately engage with a 3½-inch leadscrew (1-inch pitch) by means of clutches. The emery wheel cylinder is 20 inches diameter, mounted in a safety chuck, and can be fed to the work from 0.001 to 1-16 inch per stroke, either automatically or by handwheel, as desired. The emery wheel can easily be removed when required by running the carriage to the extreme end of the stroke, which allows a new emery wheel to be placed in the chuck without interfering with any part of the machine.

The machine occupies a floor space 10 feet 7 inches wide by

24 feet long, and weighs, approximately, 23,000 pounds. It was designed and built by The Safety Emery Wheel Co., Springfield, Ohio.

A LARGE TILTING PRESS.

The cut shows a large tilting or "tip-back" press recently built by the Perkins Machine Co. of Warren, Mass. Its builders believe it is one of the largest ever made. It weighs approximately 18,000 pounds, and may be swung backward as far as is necessary to make the punchings fall from the dies

Perkins Large Tilting Press.

by gravity. The main gear is 60 inches in diameter and weighs 1,950 pounds. The crankshaft is 6 inches in diameter at the bearings. The opening in the bed is 33 inches in diameter. A positive knock-out is applied to the plunger, being operated by the cross bar shown, which strikes adjustable stop screws on the face of the ram guide at either side of the machine.

THE BRICKNER TILTING VISE.

The Sterling Emery Wheel Mfg. Co., Tiffin, Ohio, is building the Brickner tilting vise, a tool intended for general machine shop use and adapted for work to be done in the drill press, milling machine, shaper, etc. The vise can be adjusted to any angle, from the horizontal to the perpendicular, without having the clamping mechanism interfere with the work in any way, or without making it necessary to disturb the adjustment to open and close the jaws of the vise. The jaws open 6 inches, are 2 inches high, and 5 inches wide. An 8-inch crank is furnished with each vise. The weight is about 40 pounds.

NEW DOUBLE DISK GRINDER.

Chas. H. Besly & Co., 15-17-19-21 S. Clinton St., Chicago, have recently designed a double disk grinder which is an adaptation of their regular single-head spiral disk machine. The use of two heads makes it possible to finish both sides of a piece of work at the same time, giving it smooth and parallel surface. The work is supported by a holder which can be swung in between the two disks. The body of the holder is a casting provided with a projecting handle, and clamped to a swinging bar which has a fine endwise adjustment for centering the work between the wheels. The heads are mounted on V's planed on the bed casting, and clamped in position in the same way as the tailstock of a lathe. Both spindles have about 1 inch longitudinal feed in the heads to bring the disk wheels in contact with the work. This movement is actuated either by hand lever or by foot lever, as may be desired.

A feature of this and all other double disk grinding machines built by this firm is the sliding bearing bushings which encase the spindles, and protect the bearings from emery and dust. The spindles have only about 1 inch sliding movement, so the disk wheel is always near to and readily supported by the main head casting. The spindles are 1¾ inch in diameter with cast iron split bearings, adjustable for wear. The end thrust of the spindle is taken between the pulley and the back bearing bushing on hardened and ground thrust collars of large area. The spindle pulleys are 7½ inches in diameter for a 6-inch belt. The disk wheels regularly furnished are 18 inches in diameter by ⅝ inch thick, but the machine will swing wheels 22 inches in diameter. The maximum opening between the wheels is 20 inches. The machine, complete with countershaft, press, etc., weighs about 3,500 pounds.

* * *

INDUSTRIAL NOTES FROM EUROPE.

BRITISH ENGINEERING TOPICS.

General activity still prevails in British Industrial circles. So much capital is called for in connection with business promotions and extensions that government gilt-edged securities are quoted at the lowest prices ever recorded. Much better financial returns are obtainable from commercial investments, and the spectacle is thus presented of absolutely safe securities offered at little more than 75 per cent of their par value. This point is merely mentioned as an illustration of the complicated factors which—often unsuspected by those affected—conduce to the prosperity and well-being of those associated, as manufacturers, officials, and employes, with industrial enterprises.

A feeling of unrest pervades the engineering trade in several parts of the country owing to the demands of the workmen for increased wages. There appears a disposition on the part of employers to refuse these applications, and prolonged negotiations on the matter will probably ensue.

The Lancashire cotton and engineering trades are offering strong opposition to a private bill introduced into the Houses of Parliament which proposes to make the use of metric weights and measures compulsory. In the cotton trade it is feared that any disturbance of present customs would involve an enormous outlay in changing parts of machinery, would be likely to arouse unjust suspicions of unfair dealing amongst Eastern customers, and would upset standard wages lists which have taken fifty years to build up. The engineering and cotton machine building concerns were equally emphatic in their statements during a joint representative deputation of employers and workpeople which recently waited on the president of the Board of Trade.

A feature of the last few years is the extent to which merchants handling American machine tools have been compelled to turn to British sources for supplies, in consequence, partly, of the enormous American home demand causing restricted deliveries over here. More than one of these houses either themselves build tools or control works specializing on their behalf. Another cause of this tendency is the greater demand for those British tools which have proved best adapted to insular requirements. Continental machine tools, etc., are now being actively pushed from their new London headquarters, by Schuchardt & Schütte of Berlin, Germany.

Any broad survey of British industries during the last number of years must include the developments due to the employment of capital accumulated by workmen from the profits of cooperative trading. From the smallest beginnings in the grocery, etc., line by local societies run by artisans in their spare time, an enormous business has been built up. The smaller associations, after dividing the profits quarterly, formed reserve funds and, in time, in order profitably to employ these funds, federated as the "C. W. S." or Cooperative

Wholesale Society, which is a society whose shareholders are smaller societies, and which, in addition to purchasing and distributing foodstuffs and other household necessities on a large scale, has also embarked on productive enterprises, the profits from all departments being divided amongst its constituents. Among the industries now carried on by this unique combination may be mentioned corn milling, boot and shoe manufacture, soap, its residual and allied products, jam, biscuits, furniture, clothing, tobacco, farm produce, steamship owning and running, etc. Separate organizations—which act together on matters touching their interests—exist in England and Scotland. From the last half-yearly report of the English section, it would appear that the turnover was $112,500,000, an increase of over $8,500,000 on the previous half year. The deposits and withdrawals in the banking department totalled $275,000,000, an increase of $18,500,000. The societies' own products amounted to over $22,500,000, an increase of $4,750,000. Up to now, no engineering department has been attempted, the industries touched being those capable of being worked on repetitive lines without much originality being required. It must, however, be admitted that the best machinery obtainable has generally been employed.

Some perturbation has been caused in Staffordshire by the action of German firms who have induced a number of expert chain makers to leave Cradley Heath, the home of this industry, in order to train German workmen in the manufacture of heavy anchor chains, etc., hitherto practically a monopoly of the district. It is not yet certain whether, by this action, a permanent displacement of a portion of this important trade will result. The migration of the expert workmen has been strongly opposed by both employers and the general body of workmen. The making of small chains is carried on in this district in many cases under conditions which disgrace civilization, women and girls forging the chains at their own homes for miserable wages. A certain amount of organization of workers has, however, taken place recently, with the result of wage advances of 10 to 20 per cent with some prospects of general improvement in environment. Men employed in the heavier branches are in a position to earn good wages in many cases, though from what I have seen, few of them ever work on Mondays, and in many shops the men employ a messenger solely to bring in beer for consumption during working hours. I have been informed by a prominent manufacturer that one special reason for the strong position occupied by Cradley Heath in the chain-making industry is the quality of coke or breeze employed. This breeze is made from coal mined locally, and the seams containing it are practically restricted within a very small radius of the town.

Certain machine shop accessories in the way of chucks, vises, etc., have been very successfully specialized in by Charles Taylor, of Birmingham, who manufactures large numbers of self-centering chucks which combine powerful grip with great durability. His machine vise, which gives quick adjusting facilities and good grip, also draws the work down onto the packings. It has been extensively produced—and imitated. His concern is broad enough to recognize the good points of American chucks for many services, and merchants them with his own lines. A comparatively recent product of this house is the "Instanter" bench vise, arranged for rapid manipulation (see MACHINERY, October, 1904). Predecessors and contemporaries in this field who have made capital records and experience constant expansion include Messrs. Parkinson, of Shipley, and Enturstie & Kenyon, of Accrington. Other makers, who are paying attention to the matter of independent four-jaw chucks include Dean, Smith & Grace, Ltd., Keighly, who, by the way, have recently considerably extended, and Lang, of Johnstone, N. B. The increasing use of high-speed tool steel, under favorable conditions, is mentioned by one of these firms as leading up to the special treatment of chucking facilities, and the other concern gives as a cause for success the greater energy infused into their work by men working on modern premium and bonus systems.

Metal-sawing machinery has also a number of exponents who each contrive to bring into prominence various meritorious features. Isaac Hill & Co., Derby, pioneered the "flush side" circular saw which allows of cutting "gates" or "risers" from large steel castings. Quite a number of makers exploit other variants of the circular saw, and in the band-saw line may be mentioned Noble & Lund, Newcastle; B. & S. Massey, Manchester, and Clifton & Waddel, Johnstone, N. B. E. G. Herbert, Ltd., Manchester, has considerably enlarged the scope of the power hack-saw by the introduction of the "Eccentric" pattern, which deals rapidly with sections up to 18 x 30 inches The firm also makes hack-saws for handling materials up to 4 inches diameter, entirely automatically, the cycle of operations continuing automatically until the entire bar of material is cut up into uniform lengths, when a bell rings to warn the attendant. John Holroyd & Co., Ltd., make a line of large hack-saws in which the work slowly revolves while being cut, with consequent increased production. A Midland firm which prefers to remain anonymous to a large extent, its product being factored rather than sold direct to users, is producing a hack-saw for work up to 4½ inches diameter, in which straight cutting has been the principal object aimed at, this being attained by means of a quadrant bracket which steadies the saw frame throughout its movements through the piece, and which admits of any side play being taken up for an indefinite period. JAMES VOSE.

Manchester, March 18, 1907.

MISCELLANEOUS FOREIGN NOTES.

POWER TRANSMISSION ON LARGE SCALE IN FRANCE.—A 1,100 foot head is being utilized in a new hydro-electric plant on the Siagne River, a stream of the Maritime Alps in Southern France. A 30,000-volt transmission line is now in the course of construction to Marseilles. The length of this line will be nearly 100 miles.

THE ERNST SCHIESS MACHINE TOOL WORKS AND FOUNDRY in Düsseldorf, Germany, has been turned over to a company under the name of Ernst Schiess Werkzeugmaschinenfabrik A. G. The company is to continue the building of machine tools as well as buying and selling machinery of all kinds. The capitalization is 3,300,000 marks.

INTERNATIONAL EXPOSITION IN BELGIUM.—A world's fair and international industrial exhibition will, according to a statement made upon the authority of the Belgian government, take place at Brussels, Belgium, in 1910. The exhibition will be held under the auspices of the Belgian government. This exposition is expected to be the largest in Europe since the world's fair in Paris, 1900.

NEW FRENCH MACHINE TOOL COMPANY.—A number of French business men, actively engaged in the automobile industry, have formed a company with a capital of $1,200,000 for the manufacture of machine tools, particularly such as are required for automobile construction. It is not as yet definitely settled upon where the works will be located, but it is likely that they will be erected in Puteaux, near Paris.

AUTOMOBILE SERVICE IN AUSTRIA.—The reports from Europe indicate that the motor car has been put to commercial use to a far greater extent there than it has in this country, where it has been mainly devoted to pleasure or luxury. The Austrian government is now intending to provide all districts, where railroads would not pay, with automobile service. This movement has been received very favorably by the communities concerned. Only in a few instances opposition has been met with because of the fear that the automobile service would retard the construction of railroads.

THE EFFECT OF THE TARIFF ON GERMAN MACHINE INDUSTRY.—The U. S. Consul-General at Frankfort, Germany, reports that the German machine tool builders are not particularly pleased with the new German tariff on machinery. The increase in the tariff duties handicaps not only the importation of necessary machine tools, but on account of the accompanying treaties with foreign countries, handicaps the exportation as well. Germany with its hitherto low tariff on machinery has in a few years built up an enormous trade with foreign countries, importing as well as exporting during 1906 nearly twice as much as it did five years ago. It is doubtful whether there will be very many interests in Germany that will benefit from the curtailing of the country's trade.

The Bicycle Business in Great Britain During Year 1906.—The London *Statist*, in reviewing the cycle industry in the United Kingdom in a recent issue, says: Speaking generally, the year just ended has proved one of the most satisfactory that the trade has yet had—the works have been busier and the output greater than at any other period. On the other hand, the larger output has been accompanied by a smaller margin of profit than was the case when there was a "boom" in the industry in 1897. So that with a broader basis the trade is in a healthier condition.

The Financial Aspect of the Machine Building Business in Germany.—The yearly statements of German machine firms show that from a financial point of view the past year has been one of great business prosperity, and not only has the production been greater than ever before, but the dividends paid on the capital invested are so high as to indicate a far more than normal prosperity. Out of nine firms taken at random, as reported by the *Zeitschrift für Werkzeugmaschinen und Werkzeuge*, none paid less than 7½ per cent, one paid 9 per cent, four paid 10 per cent, one 12 per cent, one 14, and one 34 per cent dividend. In general it seems that the machine building firms in Germany pay a very high interest on the capital invested, as the dividends in the previous year were in most cases the same or only 1 per cent less than those reported for 1906. On the other hand at the meeting of the Trade Guild held in Berlin in March, in reviewing the past year, it was reported that although the year had been one of great gross profits, a number of the works at the close of the year showed very meagre profits. This is attributed to the great increase in price of raw materials and half finished products. The Trade Guild, however, appears to be a combination of the kind which we generally class as trusts, and the failure to realize great profits may have been due to its trust methods which do not work well in competitive business. It was intimated that a great deal of the difficulties encountered was on account of the competition of works not affiliated or organized for syndicate working. These works, as far as we understand, are the ones that have shown very high profits. As the machinery trade is a purely competitive business, one feels obliged to admit that it is gratifying to see that the smaller competing firms are able to hold their own against the combination referred to.

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PERSONAL.

Edgar Bloxham, Paris, France, importer of machinery and tools, visited the United States in March and April in the interest of his business.

Fred A. Geier has been made president and general manager of the Bickford Drill & Tool Co., Cincinnati, Ohio. F. M. Huschart, formerly of the Marshall & Huschart Machinery Co., Chicago, is assistant to the president and is managing the Bickford plant.

William J. Kaup, the head of the machine shops of Pratt Institute, Brooklyn, N. Y., will be granted leave of absence during the academic year of 1907-08. In view of this fact, the associated evening machine classes met at the Institute club on the evening of March 20 and presented to Mr. Kaup a handsome gold watch. The following paragraph expresses the spirit of the classes in making the presentation, and is engraved in the case:

"Presented to Mr. William J. Kaup by the Associated Evening Machine Classes of Pratt Institute as a token of our appreciation of his untiring zeal in our behalf as students and men. March 22, 1907."

* * *

FRESH FROM THE PRESS.

The Theta-Phi Diagrams. By Henry A. Golding. 126 pages, 5 x 7 inches. 48 cuts and diagrams. Second edition. Published by the Technical Publishing Co., Ltd., Manchester, England, and D. Van Nostrand Co., New York. Price, $1.25.

This work endeavors to show the use of the temperature-entropy diagrams and the various methods of drawing them for different heat motors. Little change has been made in the second edition. To give an idea of the character of the work the headings of the chapters may be enumerated. Entropy; Entropy of Water and Steam; Conversion of Indicator Diagram to Entropy Diagram; Heat Losses; Application to the Gas Engine; Application to Oil and Air Engines.

Lubrication and Lubricants. By Leonard Archbutt and R. M. Deeley. 528 pages, 5½ x 8½ inches. 157 cuts. Published by Chas. Griffin & Co., Ltd., London, and J. B. Lippincott Co., Philadelphia. Price, $6.00.

The book in review is of the second edition, the first edition having been published in 1899. The work is an excellent companion book to our American book, "Friction and Lost Work in Machinery and Mill Work," by Robert H. Thurston. It contains a much more thorough treatment of lubricants, and describes a large variety of apparatus. The second edition has been thoroughly revised and considerable new matter added, including a brief account of Lasche's experiments. The book can be heartily recommended to those interested in the subject of friction and lubrication, tests of lubricants, and the general subject of lubrication of machinery.

Modern Steam Engineering. By Gardner D. Hiscox. Electrical section by Newton Harrison. 487 pages, 6 x 9 inches. 405 cuts. Published by Norman W. Henley & Son, New York. Price, $3.00.

The opening chapter is devoted to the history of the steam engine, following which steam and its properties are discussed. Chapter III is on the generation of steam furnaces and their adjuncts, the various grate constructions of furnaces, etc. Then are taken up in order types of boilers, chimneys, feed-water heaters, motors, generators and steam pumps, boiler incrustation, flow of steam through orifices, superheated steam, adiabatic expansion of steam, the steam engine indicator, steam engine proportions, the slide valve and valve gear. Corliss engines, compound engines, triple and quadruple expansion steam engines, the steam turbine, mechanical refrigeration, the elevator, the cost of power, the engineer and his duties. The electrical section by Mr. Harrison treats briefly of the dynamo and its regulation and testing; motors; the switchboard and storage batteries; lighting and lamps. From the foregoing it will be seen that the book is of a very comprehensive character. It brings together in one volume a large mass of information valuable to the working engineer. The addition of the electrical section is an excellent feature, for there are few engineers nowadays who do not require considerable practical knowledge of electrical apparatus. A feature that will be popular is the questions and answers to the chapters in the electrical section. The book is well printed and well bound and excellently illustrated. Numerous tables are included, there being a total of over 40 in the work.

Bulletin No. 9. An Extension of the Dewey Decimal System of Classification Applied to the Engineering Industries. By L. P. Breckenridge and G. A. Goodenough. 72 pages, 6 x 9 inches. Published by the University of Illinois, Urbana, Ill.

The Dewey decimal system of classification is well-known to librarians and others who have to do with the arranging and cataloguing of books, pamphlets, drawings, information, etc. It is the most simple and comprehensive scheme of the kind that has ever been devised. Considerable use of it has been made in engineering and industrial work. It has been adapted, for instance, to the filing of technical data, catalogues, reports, card systems, drawings, etc., and it has been found equally useful for manufacturing and business concerns. As originally developed the classification was not minute enough for technical and industrial uses of this kind. This pamphlet is the result of some years of study and experience in the work of expanding the classification to meet the most severe requirements of modern conditions. The first edition was a small pamphlet of six pages. The demand for it was so great that within a year a second edition was printed and this has been followed by third and fourth editions. In each successive edition the expansion has been carried somewhat further, in the third was incorporated with slight modifications the expansion for railroads and railroad engineering adopted by the International Railway Congress. In this present issue are included the expansions already worked out, and the expansion for electrical engineering made by Mr. J. M. Bryant of the electrical engineering department of the University of Illinois, together with more or less complete extension for other branches of engineering. The whole, it is hoped, will be a self-contained classification which will cover with comparative completeness the entire ground of engineering industry. So far as we know there has been no other expansion of this kind worked out, and as this seems to have been made with great care, we see no reason why it should not be adopted by everyone who has anything in the way of books, pamphlets or data of an engineering nature which he desires to file and keep track of. No one who has anything of this kind to do should be ignorant of the merits of the Dewey decimal system. This pamphlet, combined with a bulletin of the Library Bureau of Boston and New York entitled "Decimal Classification and Relative Index," will give anyone a good working knowledge of the system.

NEW TRADE LITERATURE.

Western Electric Co., Chicago, Ill. Folder calling attention to the Western Electric motors for ventilating fans.

Link-Belt Co., Philadelphia, Pa. Revised price list of sprocket and traction wheels.

The Massachusetts Institute of Technology, Boston, Mass., has issued a booklet outlining its summer courses for 1907.

Gisholt Machine Co., 1316 Washington Ave., Madison, Wis. Leaflet describing a method of finishing flywheels in one operation.

The University of Pennsylvania, Philadelphia, Pa., has issued a book descriptive of the Engineering Building recently erected there.

Irland Pipe Wrench Co., 15 Court Square, Boston, Mass. Leaflet descriptive of the Irland automatic wrench.

Independent Pneumatic Tool Co., First National Bank Bldg., Chicago, Ill. Circular E, illustrating types of Thor air hammers and drills.

B. F. Sturtevant Co., Hyde Park, Mass. Bulletin 143 on generating sets with horizontal engines, describing and illustrating these sets as used with class H C 1 engines.

The Heald Machine Co., Station D-2, Worcester, Mass. Circular illustrating the Heald ring and surface grinder and giving a list of some of the customers using this machine.

Dodge & Day, Drexel Bldg., Philadelphia, Pa. Illustrated pamphlet No. 16 entitled Methods and Work of an Engineering Organization, being one of a series concerning recent work done by this company.

Keuffel & Esser Co., 127 Fulton St., New York. Recent circulars describing automatic print hanger, folding rules, and pocket calculator.

Arthur M. Duff, publisher, 52 Canton St., Boston, Mass. Leaflet descriptive of wage calculator books designed to save all figuring and errors in the computation of wages.

The Owen Machine Tool Co., Springfield, O. Circulars illustrating and giving specifications for No. 2A universal miller, No. 2B plain miller, No. 3A universal miller and No. 3B plain miller.

The High Duty Saw & Tool Co., Eddystone, Pa. Illustrated catalogue descriptive of its line of high duty sawing machines and Tindel high-speed steel saw blades.

J. H. Wagenhorst & Co., Youngstown, O. New circular illustrating their electric blueprint machines. A list of the users of this machine and references from various companies are included.

Armstrong Bros. Tool Co., 113 N. Francisco Ave., Chicago, Ill. Catalogue No. 14 illustrating and giving tables of specifications for Armstrong tool-holders.

Rotary File & Machine Co., Inc., 589 Kent Ave., Brooklyn, N. Y. Booklet illustrating and describing band-saw machines, sharpeners, setters, blades, guides and brazers.

The Ashcroft Mfg. Co., 85 Liberty St., New York City. Catalogue for 1907 describing various gages, indicators, pipe stocks and dies, ratchets and other instruments and tools manufactured by this company.

The Knecht Bros. Co., 819 Wade St., Cincinnati, O. Circular setting forth the advantages claimed for the Knecht friction sensitive drill. Those interested in this drill may obtain further particulars by sending the post card attached to the circular to the company.

Goldschmidt-Thermit Co., 90 West St., New York City. Description of the Thermit welding process and of repair jobs made by this process. Special attention is called to its application to the transportation companies.

Ballinger & Perrot, Philadelphia, Pa. Pamphlet on concrete industrial plants, being illustrated with examples of reinforced concrete industrial construction, with descriptions of the systems of construction.

Philadelphia Gear Works, Inc., Seventh and Cherry Sts., Philadelphia, Pa. New catalogue containing all necessary information relative to the stock gears of the company, and giving rules and tables for figuring gears.

Patterson, Gottfried & Hunter, Ltd., New York. Catalogue of 260 pages on blacksmiths' tools. While the catalogue pertains essentially to blacksmiths' tools, it also contains information of general interest to machinists and repair men as well. When writing for a copy ask for catalogue 119.

Wells Bros. Co., Greenfield, Mass. Catalogue No. 22 on screw-cutting tools and machinery, containing descriptions and illustrations of screw plates, taps, dies, reamers, gages, bolt cutters and nut tappers, etc. In addition to its regular line of tools here described, the company makes a variety of special tools.

The Cleveland Twist Drill Co., Cleveland, O., has issued a set of ready reference cards containing data upon taper shanks, drill list for taps, high-speed steel drills, etc. These sheets are so arranged that they can be hung up and easily referred to. A set will be sent to anyone upon making application.

The American Locomotive Co., 111 Broadway, New York, has issued a pamphlet describing a rotary snow plow, giving a brief account of the work done by this type of plow in fighting snow on various railroads. The pamphlet contains a set of rules for the guidance of those operating this type of machine.

Baldwin Locomotive Works, Philadelphia, Pa. Pamphlet entitled "The Actual Efficiency of a Modern Locomotive," being No. 60 of this series on locomotive construction and related matters. The subject matter is a paper read by William Penn Evans before the Pacific Railway Club, February 17, 1906.

Expanded Metal & Corrugated Bar Co., St. Louis, Mo. Catalogue comprising a collection of illustrations showing the work done with the corrugated bar in a variety of structures, some information concerning corrugated bar, and simple formulas and tables for use in designing.

Israel Ludlow, superintendent of the Aeronautical Bureau, Jamestown Exposition, New York, has sent us a list of the aeronautical competitions which will be held at the Jamestown Exposition at Norfolk, Va., April 26 to November 30, 1907. The list includes twenty-five events and include dirigible balloon competition, flying devices heavier than air, kites, etc.

Bantam Anti-Friction Co., Bantam, Conn., has issued a new catalogue calling attention to several new ideas relating to roller bearings, some of which may be noted on pages 6, 13, 18, 21, 22, 23 and 24. Reprint of an article on the Mechanical Design of Ball Bearings and Roller Bearings, contributed by W. S. Rogers to the *Engineering Magazine* is also included.

Miami Valley Machine Tool Co., Dayton, Ohio. Catalogue of the Miami Valley lathe and drills. At the present time the company builds a 13½-inch engine lathe and 12-inch and 14-inch sensitive drills. The size of the lathe and its modern features make it a machine desirable for manual training school work as well as for general manufacturing purposes.

Record of Transportation Lines Owned and Operated by the Pennsylvania Railroad for the year ending December 31, 1906. 45 pages, 9 x 12 inches. Published by the Pennsylvania Railroad, Philadelphia, Pa. The record gives the names of the various railways, ferries and canals, and general data regarding same. It includes a large map in colors, showing the ramifications of this enormous transportation system.

American Locomotive Co., 111 Broadway, New York, has recently issued a pamphlet devoted to the Mogul type of locomotive. This is the seventh of a series being published by the company to include the various standard types of locomotives. It illustrates and describes 25 different designs of the Mogul type built by the American Locomotive Co. for various railroads. These types range in weight from 49,000 to 187,000 pounds. A copy will be sent on request to those interested.

T. R. Almond Mfg. Co., 85 Washington St., Brooklyn, N. Y. Advertising novelty in the shape of a salesman's advance card, being a folder in which is pasted a photograph of the salesman opposite a "window" cut out of the front page. The frame of the window is the outline of an Almond chuck. This advance sheet is sent by the Almond salesmen to their customers, notifying them of a future visit of the salesman to their place.

The Whitman & Barnes Mfg. Co., Chicago, Ill. Catalogue of "Diamond" high-speed twist drills and reamers made from W. & B. high-speed steel. These drills and reamers are made at the Akron, Ohio, factory of the the company, and cover a wide range of sizes. They are hardened and tempered by special processes which enable the production of tools which give the maximum wearing qualities and still retain the requisite toughness to prevent splitting and breaking. A large stock of high-speed drills is carried, and prompt shipments can be made.

Derrick's British Report is the title of a new periodical started in January, 1907, and published by Mr. Paul E. Derrick, 34 Norfolk Street, Strand, London. The price is $10 per year. It is intended to be a careful digest of present British market conditions, and is published in the interest of manufacturers seeking trade extension for goods sold under an advertised name or registered trade mark. The February issue contains a number of able articles reviewing trade conditions at home and abroad.

A particularly timely article in the May *Century* is that by George M. Stratton on "Railway Disasters at Night." Mr. Stratton, professor of experimental psychology and director of the psychological laboratory at Johns Hopkins University, in his story sounds a note of warning anent the failings and dangers of our present system of signals and the need of revising it. He has gone into the subject thoroughly, taking up the signals now in use from point to point, with their fault, the reasons why they fail, and making suggestions for a more reliable system of protection that are not only based on science, but on sound common sense. Other features of this issue are the sketch of Jamestown by Thomas Nelson Page, especially pertinent because of the opening of the Jamestown Exposition, "Stories of Whistler" by Otto Bacher, Earnest Rhys' "William Sharp and Fiona Macleod," and the continuation of the serial stories "The Shuttle" and "Come and Find Me."

MANUFACTURERS' NOTES.

The Sterling Emery Wheel Mfg. Co., Tiffin, O., is making a large addition to its factory.

Goldschmidt-Thermit Co., New York, has removed its offices to the fourteenth floor of the West Street Building, No. 90 West Street, between Cedar and Albany Streets.

Armstrong Bros. Tool Co., 113 N. Francisco Ave., Chicago, Ill., has received a medal for its exhibit at the recent international exhibition held at Liege, Belgium, for lathe and planer tool-holders.

Crocker-Wheeler Co., Ampere, N. J., has established a branch office in Birmingham, Ala., to handle its rapidly increasing Southern business in electric motors and generators.

Machinery Exchange, 10 Oliver St., Boston, Mass., is now the headquarters of 30 firms selling machinery, appliances and materials. The exchange has grown rapidly, having more than doubled the number of firms represented within a year.

Pittsburg Automatic Vise & Tool Co., Pittsburg, Pa., recently made a large shipment of vises to the Texas Central Railway Co. The capacity of the company has been increased so that it is in position to fill all orders immediately, regardless of the size or style of vise.

W. Gerhardi Works, Lindenscheid, Westphalia, Germany, desires to receive American catalogues, booklets, circulars, reference lists, etc., of all classes of machines and tools, special and automatic machinery of every description, power plant equipment, electrical equipment and of the hardware trades.

The Xylotite Product Co., Cincinnati, Ohio, formerly manufacturer of fiber pulleys, has discontinued the business, and the machinery has been sold. Mr. Mark Muggeridge, who was general manager of the plant, has taken the position of general superintendent of the Queen City Machine Tool Co., Cincinnati, Ohio.

Krips-Mason Machine Co., Inc., 1636 N. Hutchinson St., Philadelphia, Pa., has established a New York office at 125 West 23d St., with Mr. Edgar A. Wilhelmi as its selling agent. The business of the Krips-Mason Machine Co. is the building of special machinery for making washers and metal specialties.

Nutter, Barnes & Co., Boston, Mass., are now located at their new factory, 326 A St., where, with increased floor space and a more complete equipment of tools, they expect to be better prepared to meet the increasing demand (which has more than doubled in the past year) for their metal saw cut-off machines and automatic saw sharpeners.

American Locomotive Co., 111 Broadway, New York, has received the following list of locomotive orders for delivery to foreign countries: Two 8-wheel passenger locomotives for the Canton Hankow Railway, China; three Prairie type tank locomotives for the Yueh Han Railway, China; five Prairie type tank locomotives for the Yokohama Railway of Japan; two 4-wheel type saddle tank locomotives, Government Railway of Guatemala; and three Mallet type locomotives, Central Railway of Brazil.

The S. Obermayer Co., Cincinnati, O., will entertain the Pittsburg Foundrymen's Association in June. A special train will take the guests to the new Obermayer plant at Rillton, Pa. This new plant is the latest addition to the already large manufacturing capacity of the company and makes a total of five plants operated by them for the manufacture of foundry facings and supplies, located as follows: Cincinnati, Chicago, Pittsburg, Larimer, Pa., and Rillton, Pa. Rillton is only a short distance from Pittsburg, in the heart of the Westmoreland district, on the line of the Pennsylvania R. R.

Niles-Bement-Pond Co., New York, has opened new offices in Chicago on the sixth floor of the Commercial National Bank Building, Clark and Adam Sts. The Pratt & Whitney Co. will abandon its showroom at 46-48 S. Canal St. and will combine its machinery sales department with that of the Niles-Bement-Pond Co. The Pratt & Whitney small tools show room and stock room will be located on the ground floor of the new Plamondon Bldg., Clinton & Monroe Sts., where a complete list of small tools and gages will be carried in stock. Mr. Geo. F. Mills will continue as manager of the Chicago office.

The Peerless Rubber Mfg. Co., 16 Warren St., New York, has broken ground for a large three-story factory building at its already extensive plant at New Durham, N. J. The additional capacity afforded by the new building will give the company one of the largest mechanical rubber plants in the world. There will be installed several new calendering machines, a number of presses for mold work and a new battery of washers, grinders, mixers, etc. The improvements, when completed, will add about 30 per cent to the present capacity.

The March 28 meeting of the Technical Publicity Association at the Aldine Club, New York, was "house organ" night, the subject being the periodical publications issued by various manufacturing concerns to advertise their products. The editors of the successful house organs issued by a number of the leading manufacturing concerns were present, and several made addresses. In some cases the house organ has taken the place of the advertising in the trade press altogether, and in other papers the trade magazine has been used to supplement regular trade paper advertising.

Modern Machinery & Engineering Company, Cleveland, Ohio, has been incorporated, and has acquired the business as selling agents for the Potter & Johnston Machine Co. and Landis Tool Co., formerly conducted by W. E. Flanders, with offices at 309 Schofield Bldg., and 933 Monadnock Block, Chicago, Ill. Thomas F. Ahern, M.E., who has been manager of the Chicago office for the past two years, and formerly with the Pratt & Whitney Company, is treasurer of the new company. The company has received an order for $150,000 worth of machinery equipment for the new plant of the Rainier Motor Car Co., Detroit, Mich. It is expected that this plant will be in operation by June 15, and that about 600 cars will be turned out in 1908.

The seventh annual session of the "Summer School for Artisans" of the University of Wisconsin begins June 24 and continues six weeks. Courses of study are offered on engines and boilers, applied electricity, mechanical drawing and machine design, materials of construction, fuels and lubricants, shop work and manual training. The entire laboratory and shop equipment of the College of Engineering is used by the students in the summer school. The requirements for admission are only a working knowledge of English and arithmetic. Further information may be obtained from Mr. Frederick E. Turneaure, Madison, Wis.

The American Pulley Co., 29th and Bristol Sts., Philadelphia, Pa., has lately completed important additions to its plant. During the past year the factory has been equipped for making pulleys 44, 46 and 48 inches in diameter, from 6 to 16 inches face (diameters and faces varying by 2 inches), so that the total range of sizes which can now be had of this type of pulley is from 6 to 48 inches diameter, and from 2 to 16 inches face, according to diameters. In 1897 the output of the company for the year was 18,000 pulleys from 6 to 24 inches diameter; in 1906 the output was 200,000 pulleys from 6 to 42 inches diameter. An eight-arm pulley has recently been added to the line.

The American Locomotive Co., 111 Broadway, New York City, at the coming Jamestown Exhibition will occupy a plot 100 x 250 feet in the southern portion of the grounds on the southeasterly side of Lee's parade grounds. The exhibit will be housed in a building especially

RAILWAY MACHINERY.

A special edition of MACHINERY devoted to Locomotive and Car Equipment and Mechanics.

June, 1907.

ITALIAN PRAIRIE BALANCED-COMPOUND LOCOMOTIVES, AND THEIR FUTURE.

CHARLES R. KING.*

THE locomotive here illustrated is the first four-cylinder locomotive that has been designed under the new *régime* of the State Railways of Italy. The first specimen has just been delivered to the State Railways in the presence of the Director-General of Italian Railways and a special delegation.

The engine proper is of the Plancher compound system, notable for having only one valve for one pair of cylinders, and each high-pressure and low-pressure valve independently variable in length of travel. Hitherto the relative cut-off for each group of cylinders has not been variable from the footplate. In the Prairie type engines there are two reach-rods, permitting the two valve-mechanisms to be operated independently. It remains to be seen whether, in this particular case, the duplicate reversing will be maintained permanently; in the general run of practice on the European continent, duplicate reversing gears are abandoned as soon as a proper ratio has been ascertained for the percentages of expansion in the two groups of cylinders. As, however, the grades to be worked by the new engines vary greatly, it is not certain that a fixed ratio will be economical.

This new locomotive is especially worthy of attention for its general design, which is radical. It is an extraordinarily supple machine considered as a carriage. The driving-wheel springs are equalized with the trailing-wheel springs. The front connected-wheel spring is set transversely, so that the engine frame is only supported in the center line. The pony-truck is carried on swing-links, the lateral control being effected by pairs of volute springs. A very small amount of lateral play is also allowed at the other end of the engine, in the trailing axle-boxes. Every axle-box, from end to end of the engine, is fitted with rotating liners of Zara's patent (Fig. 2) so that in entering or leaving curves, or whenever the axles momentarily assume a position out of square (vertically) with the frames, the rotating liners permit all such movements, contrary to the usual action of axle-boxes, which, in resisting these movements, set up injurious strains that ultimately fracture the fatigued portions. That there is real utility in articulated axle-boxes may be assumed from the fact that, in the first three years of their introduction, over 2,000 Zara boxes were in use. (See RAILWAY MACHINERY, October, 1906.)

The interesting feature of the pilot truck consists in the application of a swinging pivot to the arrangement of conjugated axles usual with the pony truck, introduced some years ago by Mr. Helmholtz of the firm of Krauss in Munich, Bavaria, so that the frame of the truck is no longer connected to the leading axle through a rigid fulcrum, as in Krauss, but through a center which is displaced in such manner as to allow the first pair of driving wheels to be displaced laterally to the inside of the curve, according to the guiding of the front or advancing flange of the leading outside driving wheel; whereas, with a rigid pivot as in the Krauss conjugated system, the leading flange of the front outside driving wheel is necessarily jammed hard against the outside rail. See line cuts, Figs. 3 and 4.

In regular service the Krauss conjugated truck proved to be so safe that it was admitted on the railways of Germany for the fastest interurban trains for which a four-wheeled pilot truck had before been obligatory. The Italian express engine is built for speeds of 62 miles per hour, but, in the preliminary runs it made before being sent to Firenze (Florence) for its dynamometer tests, it was run at speeds of 66 miles per hour. This was in February, on the line to Chiasso (Switzerland) and to Piacenza. The truck had already been tested in previous Italian locomotives and upon the electric locomotives shown in RAILWAY MACHINERY issue of February, 1907, both of which electric locomotives are from the drawings of the designer of the locomotive under mention. Much attention has been given in the technical press to these Simplon locomotors, all ignoring this novel truck fitted at their two extremities, and also the fact that they were schemed by a railway engineer of life-long experience; the motors they carry presenting little of interest to railway engineers. It was while Signor Zara was designing these Prairie electric locomotives in collaboration with the locomotive engineers of the works of the Hungarian State Railroads at Budapest, in June, 1903, that the writer heard him state his reasons for adopting the conjugated pilot-truck in these locomotors, which have many points in common with his new locomotives.

This and the subsequent digression may perhaps be excused, as they show that in Italy, as elsewhere, machines for railways must be designed by those who have made railways their lifelong study. It is most possible, however, that after several more attempts at electrical traction with the same uneconomical results as the chief Italian venture in this direction (that is, the electrified line from Milano to its north-

Fig. 1. Italian Prairie Balanced-compound Locomotive.

* Address: Woodland Crescent, Downend Bristol, England.

ern suburbs) Italy will replace electricity with self-propelled steam trains. Of this change there has long been question in regard to the line just mentioned, despite the news periodically circulated in the foreign press since the year 1902, in the stereotyped phrase: "All the steam railways of Northern Italy will soon be electrified." The real fact is that the steam locomotive has been wrought to a high state of perfection in Italy, and its superior economy enables the State to handle traffic at lower cost by this means than by hydro-electric or steam-electric plants, which have proved to be the reverse of economical, while they introduce an intolerable complication in trunk-line traffic. This fact is already

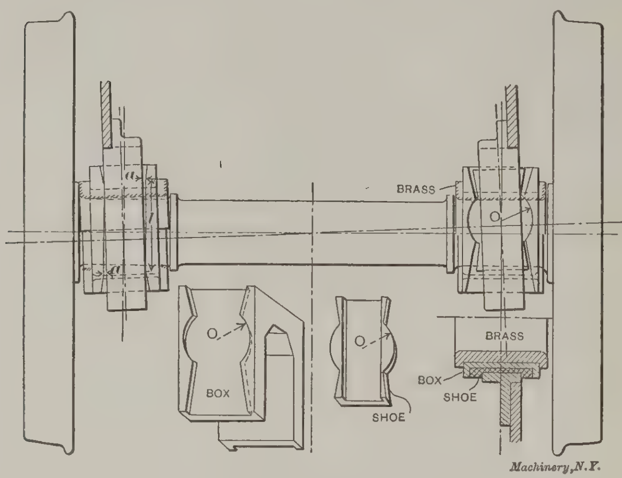


Fig. 2. Construction of Axle-boxes, Zara's Patent.

exemplified in the daily working of the Simplon tunnel, where all the international express trains are obliged to stop twice in the space of 13 miles, at out-of-the-way insignificant villages, in order to allow the electric locomotives to be coupled on. The result is comparable to the slow services of city suburban trains, with no advantage for the passengers or trainmen as regards the aeration of the tunnel; for, with steam locomotives working the trains, the most fastidious of persons could have complained of no discomfort that is not equally present with the electric locomotives, and the locomotive enginemen expressed their satisfaction with the purity of the tunnel air, and of the immaterial influence of any emanation of the locomotives upon the atmosphere.

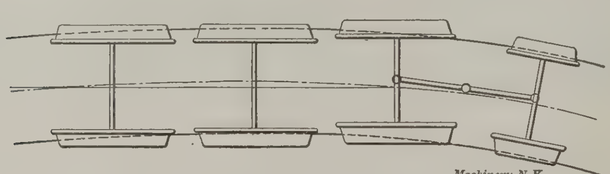


Fig. 3. Truck connected to Leading Axle through Rigid Fulcrum.

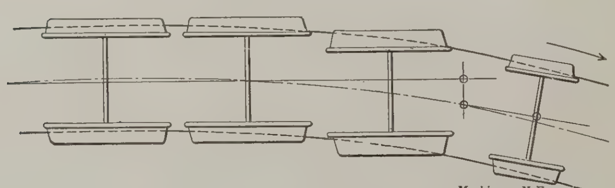


Fig. 4. Truck connected to Leading Axle through a Swinging Pivot.

The trouble that was apprehended from locomotives was not, in fact, realized in practice; but the advantage derived from the use of electric current was that of obtaining traction practically free of cost for motive power in the tunnel, since the power plant was there, already installed for the boring work of the tunnel. None the less, the Federal Railways agreed to the electrification on condition that the electric company should hand back the tunnel in right order for steam-motor working, and without claim of compensation, if electrical train operation gave rise to inconveniences; but, so far, nothing similar to the New York experience with this form of traction has occurred. Thus it will be understood that steam locomotives are more likely to replace electrical traction than otherwise in Italy, notwithstanding that 36,350,000 lire ($7,270,000) have been voted for the electrical equipment of a few short lines. The locomotive illustrated has a greater tractive effort, a higher speed-capacity and, when empty, weighs no more than the Prairie type electromotors of the same designer.

It will be noticed that in these Prairie engines the absolutely rigid wheel base is confined to the driving and rear connected wheels. The connecting side-rods work on spherical pins of the forward or conjugated wheels, in order to avoid strains on the brasses.

The boiler is representative of the latest Italian practice, although the construction is not so advanced as is that of the new Austrian Prairie locomotive. In this latter, gussets are used exclusively for staying the back sheet of the firebox, while in the Italian boilers a couple of horizontal plate stays are employed according to the general practice of the Continent. It is a singular fact that American practice in locomotive boiler construction is usually first followed in Europe by Austrian and Bavarian designers.

The throttle of the Italian engine has a three-phase action on the steam. This throttle-valve, patented by the actual designer of the locomotive described, Signor G. Zara, has been the subject of recent comment in the engineering press, because the manager of the Hunslet Engine Company, of Leeds, England, attributed to it the same principle as another throttle which had been made by this firm for some

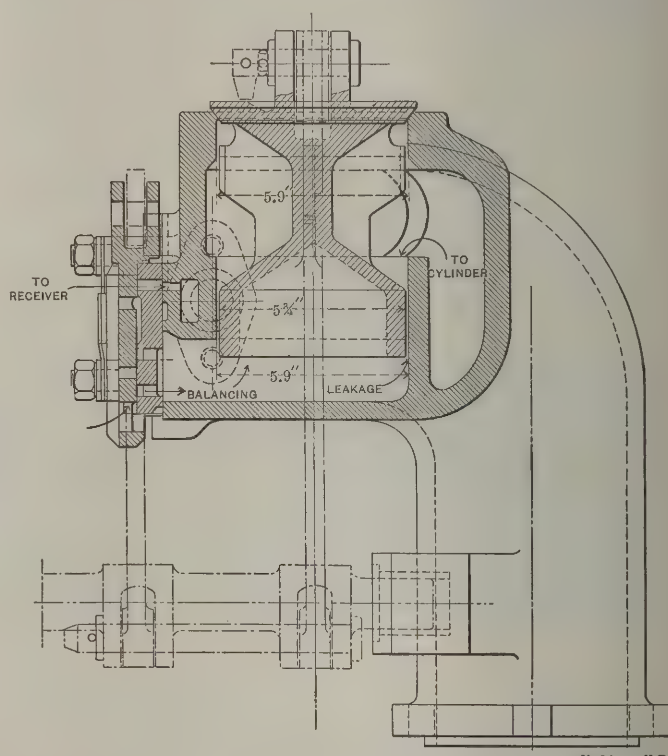


Fig. 5. Section through the Zara Steam Throttle Valve.

years past, and the idea and principle of which had been suggested by a sketch in an old number of the *Scientific American*. The drawings published with the communication of the Hunslet firm showed that, mechanically, their valve differed from the Zara valve in only one small detail—this detail constituting a vital difference in the principle of working of the two valves. The unique feature of the Zara valve, applied to the locomotive illustrated, is its three phases of admission due to the graduated openings given by the various parts of the valve. This will be understood from the detail drawing, Fig. 5. Here the lower or piston valve is shown to be a loose fit in the cylindrical part of the head, the piston measuring 5¾ inches and the bore 5.9 inches. This gives an annular opening of constant section through which the steam flows to the cylinders as soon as admitted to them by means of the balancing or pilot valve, thus applying pressure on the engine pistons without slipping the wheels. This action of the steam is termed the first period or phase. The Hunslet-American valve appears to narrowly miss this pre-admission of steam, for its pilot valve, although allowed a clearance and lift of 1-16 inch below the closely-fitting perforated lower cylindrical valve, closes these perforations

when steam is introduced below the balancing piston. The advantages to be derived from mechanically-graduated throttle admission appear to be considered of importance in Europe, where the Zara valve has been adopted by a large number of Continental railways both for saturated and superheated steam. The diagram, Fig. 6, represents the sectional openings, in square centimeters, as given by various positions of the three-phase throttle valve.

The auxiliary or double-ported valve, visible in the drawing of the throttle, admits live steam to the receiver only whenever the main valve is in the first period of its opening, and also only when the engine is in full gear. This latter is controlled by means of a miniature slide valve on the extension-rod of the high-pressure valve, so that live steam is only admitted when the engine is starting with a heavy load. The operation is automatic and the working of the engine is as simple as a two-cylinder single expansion locomotive.

The engine is particularly well balanced in its motor efforts. The cranks are keyed, as usual, at 180 degrees, the cylinders are set all in one transverse plane, and the pressure exerted on each pair of high-pressure and low-pressure cranks is absolutely equalized by the constant intercommunication of the opposite ends of the same group of cylinders. Thus the opposing efforts on each set of cranks are perfectly equilibrated, and the balancing of the rotating masses is effected with a minimum value for the wheel counterweights, thus contributing notably to the even running of the machine and to the preservation of the track. In these engines there are, of course, only one-half the number of exhausts usual with four valves having four periods. The force of the blast is regulated by means of a variable nozzle having a central cone or plug with projecting helical wings, similar to those nozzles of the "Nord" and Paris-Lyon railways of France.

The boiler is of steel; the barrel is formed of three rings having double-welt strips and six rows of rivets closing the longitudinal seams. The inside firebox is of copper, and the lower contour of the boiler barrel is welted with 0.078 inch sheet copper to preserve it from corrosion. Steel tubes having proved unsatisfactory, from their rapid pitting and sloughing with the water used, all tubes are now of brass and the ferrules of copper. Special rests on the mud-ring support the

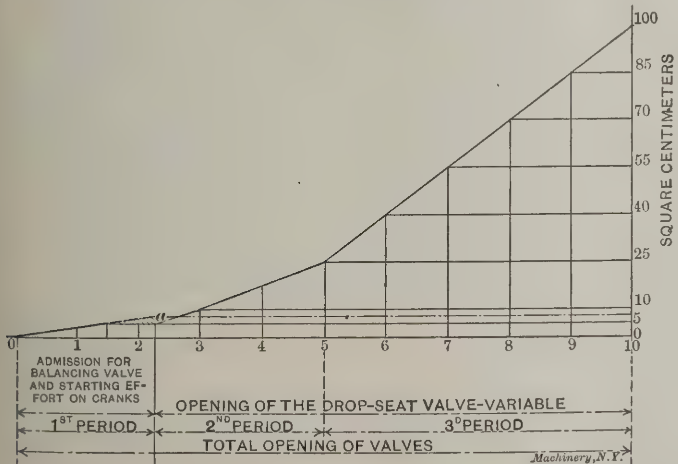


Fig. 6. Diagram of Inlet Openings of the Zara Valve.

boiler on the dilation brackets behind, and the intermediate supports are, as in American practice, of thin vertical plates allowing expansion movements of the boiler.

DIMENSIONS.

Italian Prairie Type Balanced-compound Locomotives.

Cylinders: High-pressure.........	14¼ inches
Low-pressure	23¼ inches
Piston-stroke	25⅛ inches
Boiler-pressure	215 pounds
Driving wheels diameter.........	72¾ inches
Heating surface, total............	2,539.3 square feet
Grate area......................	37.6 square feet
Weight: Engine empty...........	61.5 metric tons
Engine loaded...............	68.5 metric tons
Engine maximum adhesion...	43.5 metric tons
Total wheel-base.................	27 feet 8¾ inches
Driving wheel base (flexible).....	12 feet 11½ inches
Bearing wheels, diameter.........	37⅝ inches

ELECTRIC TRAVELING WHARF CRANE.

The accompanying illustration shows one of a lot of eight cranes now under construction by the Shaw Electric Crane Co., Muskegon, Mich., for the Panama Railroad Co. They are for use in handling miscellaneous freight at the La Boca wharf, which is the Pacific terminus of the railroad, and are of notable size. Each crane weighs about 50 tons, and when the boom is in the elevated position, it stands about 90 feet above the wharf. The cranes were designed to meet the peculiar conditions existing at the wharf, among which may be mentioned a tidal variation of about 20 feet.

The boom, which is 80 feet in length, is shown in its working position, standing at an angle a little over 30 degrees from the horizontal. It is required that the outer end should stand at sufficient height to carry loads over the decks of

Shaw Electric Traveling Wharf Crane.

the largest vessels at high tide, while the other end must be low enough to project inside of the warehouse door. The boom may be elevated to a position about 15 degrees from the vertical, carrying the outer end clear of all parts of vessels and withdrawing the inner end from the warehouse. With it in this position, vessels may be docked and the cranes placed opposite the various hatchways in proper position for loading or discharging cargoes.

The main frame or tower is of steel construction, and stands 62 feet above the track. There is a clear opening through it, 10 feet wide, in which the boom is suspended, and through which the loads are carried. The base is so constructed that the crane can travel over freight piled to a height of 6 feet between the tracks, and so that goods may be trucked directly from under the crane to the warehouse. The space between the front of warehouse and edge of wharf was sufficient for a track of only 11 feet gage. This, together with the necessary height and reach, made the question of stability a serious one. Although the weight of frame and machinery has been so disposed that the crane will be stable with a load 25 per cent above normal capacity in the extreme position, clamps have been provided which are always in engagement with the rear rail, to prevent the crane from tipping if a load should become fouled on a hatchway or other part of the vessel.

The crane is mounted on six wheels, four under the front and two under the rear. Anticipating the possibility of uneven settling of the wooden wharf, the wheels are carried in equalizers, so arranged as to compensate for any probable irregularities of track without straining the structure.

The machinery for the various movements is placed in the base of the tower, adding to the stability of the crane, and giving easy access for inspection. For convenience in shipping and erecting, each set of machinery is mounted upon a separate frame, which is easily handled and put in place.

The crane has a regular working capacity of four tons, and a reach of 40 feet from the center line between rails to the extreme outer position of load. The total height of hoist is 70 feet, and the speed hoisting with full load is 150 feet per minute. The load can also be racked out and up at a speed of 150 feet per minute. The other two movements, travel and boom hoist, are relatively slow, being required only in setting the crane in position for service.

The hoist is operated by a 65 H.P. motor, the rack motion by a 40 H.P. and the travel and boom hoist by 24 H.P. and 8 H.P. motors respectively. Automatic switches are provided to prevent overtravel in hoisting and racking out, also an overload switch for the hoist machinery. All movements are under the control of one operator, whose cab is so located as to give him the best view of his work.. The motors and controllers, as well as all structural work and machinery, are the product of The Shaw Electric Co.'s plant at Muskegon, Mich.

* * *

BORING MILL VS. DRIVING-WHEEL LATHE FOR TURNING TIRES.

The practice of changing driving-wheel tires in the roundhouse when the locomotive is not ready to go into the back shop for heavy repairs is followed with very satisfactory results on a number of roads. The ordinary practice is to shrink the tires on a pair of wheel centers and turn them in a driving wheel lathe. The labor cost of putting a pair of tires on the centers and removing them after they have been turned would amount to at least 40 cents, and the cost of the gasoline for this purpose would come to about $1.50. The actual labor cost of turning the two tires will, of course, vary in different shops, but in one shop it costs $1.50 a pair. It was found after careful investigation that the tires could be turned on a boring mill at a cost of 80 cents apiece as against $3.40 per pair or $1.70 apiece, as above. The boring mill was not of very recent design and was not equipped with a universal chuck. Two tools were used. On a modern heavy-duty mill, equipped with a universal chuck, this work could probably be handled to still better advantage. The space occupied by such a mill would not be greater than for a driving-wheel lathe, and the first cost of the boring mill would probably be less.—*American Engineer.*

* * *

It has been officially announced by the Interstate Commerce Commission that instructions have been issued to United States district attorneys to institute proceedings against 25 different railroad companies to exact penalties for violations of the safety appliance law.

MATHERAN LIGHT RAILWAY IN INDIA.

A. R. BELL.*

Nearly all the large centers of population in India have their health resorts. Calcutta has Darjeeling, Madras has Nilgiras, and Lahore and the Punjaub look to Simla. Bombay has its beauty spots among the Western Ghats, one of the most charming being Matheran, a flat-topped hill some 2,500 feet high, rising abruptly from the plain at the foot of the mountain barrier. All these various resorts can now be reached by railway, since the last named has recently been put into direct communication with Bombay by the opening of a line of 2 feet gage, constructed by two of that city's most enterprising inhabitants, Messrs. Abdul Hussein Adamji Peerbhoy and Rai Saheb Harichand, the latter being the engineer.

The railway is 12 miles long, starting at Neral Station on the G. I. P. R., 132 feet above sea level, and ending at the Matheran terminus, 2,495 feet above the sea. Leaving Neral, which is on the southeastern main line of the G. I. P., the first four miles from that station to Bheker Khund, a connecting ridge between Gadal Hill and the main ascent, are comparatively easy, but after meeting the Provincial Road at Bheker Khund, the next five miles up to the only halting place, Panorama Point, form the most difficult section of the route. The rise in this section is about 1,250 feet, with a maximum grade of 1 in 20. There are no switchbacks or reversing stations, but the line zig-zags up the side of the hill, with horseshoe curves sometimes as sharp as 60 feet radius. There are two tunnels on this section, each about 150 feet long, and at other points the line twists round sharp corners of the cliff with only a shelf or ledge cut from the rock to carry the road bed. On leaving Panorama Point, which is a rock perched at the extreme southwest corner of the hill, overlooking Bombay and its beautiful harbor, the line begins its third and final section of three miles to the Matheran terminus, in which a further rise of about 450 feet is accomplished with an average gradient of 1 in 35. There are no bridges of importance on the whole route, the railway keeping to the hill face throughout its length as closely as possible.

Fig. 1. Train on Matheran Two-foot Gage Railway in India.

At the opening of the line, the rolling stock consisted of two locomotives, fifteen first-class cars, six third-class cars, and two luggage vans with postal accommodation, for passenger traffic, in addition to two small saloons in course of construction at the G. I. P. R. shops at Parel and twelve open goods wagons. Another locomotive was taken from the Darjeeling railway, and two other locomotives are on order, and we under-

* Address: Holm Dene, Ridgway, Enfield, Middlesex, England.

stand that the number of carriages and wagons is to be largely increased.

The locomotives were supplied by Messrs. Orenstein & Koppel, and are of novel construction; they have six coupled driving wheels of 2 feet 6 inches diameter, but these wheels are not attached to the axles in the ordinary way and coupled direct. The wheel centers are each cast with one-half of a hollow axle of large diameter, the two halves being bolted together. The solid main axles with ordinary rigid bearings in the main frames, and outside coupling rods, pass through the center of the hollow axles, and by means of a ball joint at the center, enclosed by a sleeve or bush, communicate a rotary motion to the hollow axle and consequently to the driving

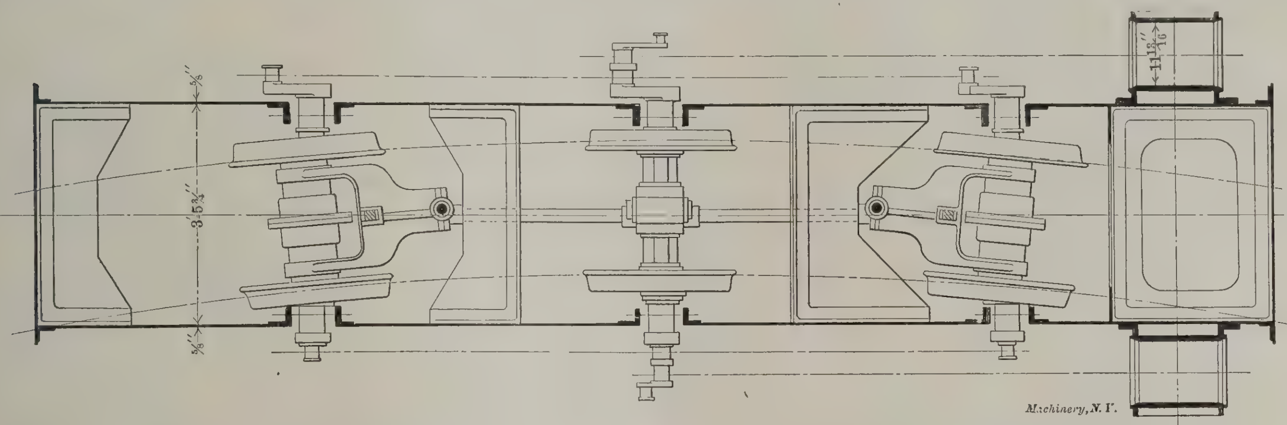


Fig. 2. Plan of Locomotive, showing Construction permitting the Passing of Sharp Curves. Wheels follow Curves without Changing Parallel Rod Center Distances.

wheels, while allowing ample side and radial freedom. The details of this form of radial axle, which is an improved and somewhat modified example of the axle patented by Mr. John Clark in 1870, will be seen clearly in the accompanying diagram, while the radial effect is shown in the plan of the engine also reproduced. The cylinders are outside the frames, 11 13-16 inches diameter by 13 13-16 inches stroke; the boiler has a total heating surface of 452 square feet, and a grate area of 7 square feet, and carries a working pressure of 175 pounds per square inch. The tanks have a capacity for 450 gallons of water, and the weight of the engine in full working order is 39,200 pounds.

The engines were originally fitted with a "counter-pressure" brake apparatus on the Riggenbach system, whereby, when the

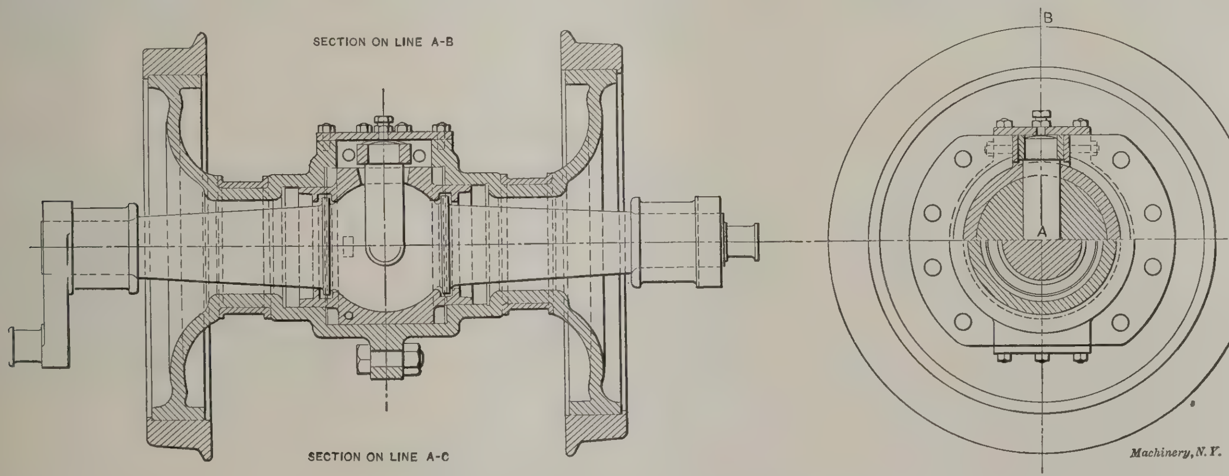


Fig. 3. Construction of Hollow Radial Axle.

engine was running down grade with the expansion gear reversed and the blast pipe closed, atmospheric air was drawn into the cylinders through the cylinder cocks and was pumped into the steam pipe to act as a retarding agent. The pressure was regulated by means of a valve in the cab under the control of the driver, who could also supply water from the tanks to the cylinders to cool them when necessary. This arrangement did not work satisfactorily, and has since been replaced by the automatic vacuum brake.

* * *

The earliest authoritative instance of a wind mill in England was one which existed at Bury St. Edmunds in 1191.

ELECTRIC RAILWAY MACHINERY AND APPARATUS.—4.

WM. BAXTER, JR.

Action of Coil in Magnetic Field.

In the last article we showed that when a wire is placed in a magnetic field, at right angles to the direction of the magnetic flux, and is traversed by an electric current, it will swing out of the field, to one side or the other, depending upon the direction of the current, provided it is free to move. We also showed that this action is due to the repulsive force set up by the flux of the field against that surrounding the wire. Keeping this action in mind, it can be seen that in Fig. 22, if the direction of the magnetic flux between the two field poles *P N* is as indicated by the arrows, the wire loop *A* will be caused to rotate around the axis *S S* if it is traversed by an electric current flowing in the direction indicated by the arrows at the sides of the loop. That this is so can be clearly understood from noting the direction of the flux in the two circles *c*, and also that of line *b*; the former representing the flux surrounding the wire, and the latter the field flux. If the direction of the current through the loop were reversed, there would be no tendency for the latter to rotate, because then the lines of force surrounding the wire would be in the same direction, on the inner side, as those of the field poles. Looking carefully at Fig. 22, it will be found that the loop, if placed exactly at right angles to the field flux, would be in a state of unstable equilibrium, and, if moved slightly up or down, would at once begin to rotate, but, if it were moved upward, it would only move a short distance before it would come to a stop, owing to the fact that the segment *C* would pass from under the contact brush *D*, while segment *B* would pass under this brush and leave brush *E*, the latter coming in contact with segment *C*. By this change the direction of the current passing through the loop would be reversed, hence, the direction of the flux would be reversed, and there would be no effort to rotate. If, however, the loop starts to rotate clock-wise, it will continue to turn until the coil has made one-half a revolution, because by this movement the relation of the segments *B* and *C*, and

the contact brushes *D* and *E* is not changed, so that the current continues to flow through the coil in the same direction. When the loop has made a half-revolution, the contact brushes will be in the reverse relation to that in which they are drawn with reference to the segments, that is, *D* will be resting on the other end of *C*, and *E* will be resting on what in the diagram is the upper end of *B*. The headway of the loop will carry it over this point, which may be called a dead center, and then *B* will slide under *D* and *C* under *E*, thus reversing the current through the coil so that it may make another half-

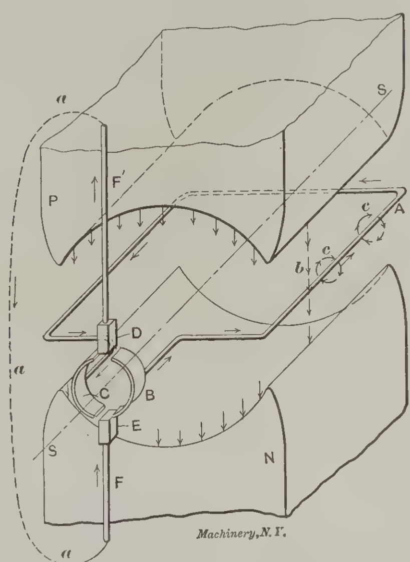


Fig. 22. Action of Coil in Magnetic Field.

revolution. At the end of this half-revolution the segments will once more reverse their contact with the brushes, so as to again reverse the direction of the current through the loop. Thus it will be seen that if the loop starts to rotate in the right direction, it will continue to revolve, and at each half-turn the direction of the current passing through it will be changed, so as to keep up the rotative force. If, however, the loop starts to turn in the wrong direction, it will only move a small portion of a revolution before the current through it will be reversed, and then it will be rotated back to the starting point.

Generation of Alternating Current.

If, instead of passing a current through the loop, we simply connect the ends of *F F′* as indicated by line *a*, and then apply power and turn the loop around, we will find that it will generate a current, and that this will consist of a series of

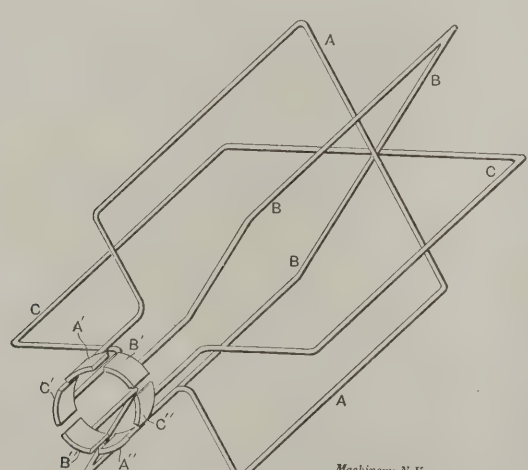


Fig. 23. Parallel Connection of Commutator Segments.

impulses that will start from zero value, as the loop passes the position at right angles to the field lines of force, and will reach the maximum strength when the loop is parallel with the field flux. These impulses will be all in the same direction, however, owing to the fact that segments *B* and *C*, which constitute a simple commutator, in connection with the contact brushes *D* and *E*, reverse the connection between the ends of the loop and the external circuit *F a F′*, at the same time that the current generated in the coil is reversed. If, instead of the segments *B C*, we placed two rings side by side, and connected the two ends of the loop with these rings, then brushes resting upon the rings would take off an alternating current that would reverse its direction at each half-revolution.

When the apparatus illustrated in Fig. 22 acts as a generator, the rotation of the loop through the magnetic flux of the field develops an electromotive force, or electrical pressure, but unless the electric circuit indicated by line *a* is closed, no current will be generated. If the circuit is closed, the strength of the current generated will depend upon two things, first, the electromotive force induced in the loop, and second, the resistance in the circuit against which the current has to be impelled. Suppose the E. M. F. (electromotive force) developed is one volt, and that the resistance of the circuit is one ohm, then the current generated will be one ampere. If the resistance of the circuit is increased to five ohms, the current generated will be cut down to one-fifth ampere. If the resistance of the circuit is reduced to one-fifth of an ohm, the current generated will be five amperes. Thus it will be seen that the strength of the current does not depend upon the E. M. F. that the generator can develop, alone, but equally as much upon the resistance that has to be overcome.

How Electromotive Force may be Increased.

The E. M. F. induced in the rotating loop can be increased in two ways, assuming that the field magnetic flux remains unchanged; one is by increasing the velocity of rotation, and the other is by increasing the number of turns of wire in the loop. Thus if a loop having one turn only, will develop an E. M. F. of one volt, a loop of two turns will develop an E. M. F. of two volts, and one of five turns will develop five volts. If the number of turns in the loop remains unchanged, then

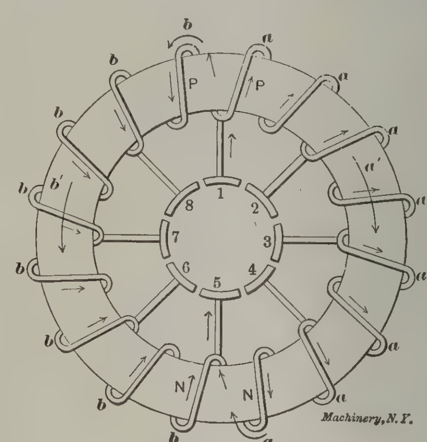


Fig. 24. Winding of Primitive Ring Armature.

if a velocity of ten turns per second develops one volt, twenty turns per second will develop two volts, fifty turns per second five volts, and in like proportion for all other speeds. If the field flux is increased, the E. M. F. induced in the loop will increase, the number of turns in the loop remaining the same. If the field flux is doubled, the E. M. F. will be doubled, and if the flux is made five times as great, the E. M. F. will be five times as great also. From this it can be seen that the E. M. F. developed by a generator can be increased by increasing the velocity of rotation, by increasing the number of turns of wire in the loop and by increasing the flux of the magnetic field.

Counter-electromotive Force.

When Fig. 22 is used as an electric motor, the rotation is developed by sending through the loop a current that flows in the opposite direction to that which the loop would generate, if acting as a generator and turning in the same direction. From this fact it can be clearly seen that when the loop is rotating as a motor, it also tends to develop an E. M. F. by acting as a generator, and from this it will be inferred at once that the loop actually puts forth an effort to prevent the current from flowing through it. This in reality is just what occurs, and the result is that if the loop is held so that it cannot turn, and a current is passed through it, this current will be much stronger than when the loop is rotating. The reason for this is that when the loop is held stationary, the only opposition the current encounters is the resistance of

the loop, but as soon as the latter begins to rotate, it develops an E. M. F. that acts to hold the current back. Suppose that the current passed through the loop is impelled by an E. M. F. of five volts, and that the resistance of the loop is one ohm, then if the loop is held stationary, the current passing through it will be five amperes. If the loop is released, it will at once begin to rotate, and while it is picking up speed, the current will gradually reduce. Suppose we find that it has reduced to one ampere, then we know that of the five volts of E. M. F. that impel the current forward, four have been offset, or balanced, by the E. M. F. induced by the loop as a result of its rotation, so that only one volt is left to drive the current against the resistance of the loop, hence, the strength is reduced to one ampere. This E. M. F. induced by the loop when acting as a motor is called the counter E. M. F. of the motor, because it acts in opposition to the E. M. F. of the operating current. In actual motors the counter E. M. F. is from about 94 to 98 per cent of the E. M. F. of the operating current, and on this account it is necessary to introduce a large resistance in the circuit of the rotating part, in the act of starting, so that the current may not rise to such strength as to burn the insulation off the wire. For the purpose of introducing this resistance into the circuit, a device is used that is called a motor starter, and it is made so as to start with all the resistance in the circuit, and to cut this out gradually as the speed increases, so that after a few seconds all the resistance is cut out and the current is held down to the proper strength by the counter E. M. F. of the motor.

As the E. M. F. induced in the rotating loop can be increased by increasing the number of turns of wire in the loop, it might be supposed that if we modified the construction in the manner shown in Fig. 23, the desired result would be obtained, but this is not the case, owing to the fact that in this arrangement the E. M. F. induced in one of the loops cannot be added to that induced in the others. Such an arrangement simply increases the current-carrying capacity, providing the contact brushes are made wide enough to cover two or three segments, so as to collect current from two or three loops all the time. The arrangement is no better, however, than the single loop with a wire of two or three times the cross section.

Wire Coils Connected in Series to Develop Electromotive Force.

To be able to make use of the E. M. F. of the several loops so as to develop a higher voltage, it is necessary that the loops be connected in series, so that the same current passes through all of them, then the E. M. F. of one loop is added to that of the other, so that two loops will give double the E. M. F., three loops three times the voltage, and so on for any other number of loops. To explain at once how the loops, when of the form shown in Fig. 23, are connected in series is difficult, and it is better to start by illustrating the simpler arrangement that is shown in Fig. 24. This is what is known as a ring armature, and the loops or coils are arranged in what is called a ring winding. Here we have a commutator with eight segments, and the armature ring is covered with sixteen turns of wire. These are divided into what are called coils, there being eight coils, with two turns to each coil. The portion of the wire that constitutes one coil is that between the connections with two consecutive commutator segments. Looking at Fig. 24, it can be seen that if a current passes into segment 1 from a brush, it will divide, and, flowing in two equal parts, will pass through all the turns of wire down to the lower side, as indicated by the arrows, and, if the other brush is in contact with segment 5, the two half currents will pass out through it. In this diagram we see that the two currents on the opposite sides of the ring advance progressively turn by turn from top to bottom, as indicated by arrows *a* and *b*, and that in all the wires on the left side the currents on the outside of the ring come toward the observer, while in the turns on the right side of the ring the currents flow away from the observer. This being the case, it is clear that if Fig. 24 is placed in the magnetic field of Fig. 22, in place of the loop there shown, that the contact brushes, instead of being on top and bottom of the commutator, would have to be placed on the sides, so that in all the wires covering the upper half of the ring, the current would flow in the same direction, say to the front, while in all the turns in the lower half, the current would flow in the opposite direction.

The construction as well as the actual appearance of a ring armature can be understood from Figs. 25 to 29, which are photographic views of such an armature in several stages of construction, as constructed by the Fort Wayne Electric Works. Fig. 25 shows the bare ring with the plates by means of which it is secured to the spider shown in Fig. 26. The ring is made of a large number of rings punched out of thin sheet iron and firmly clamped together. The supporting plates surrounding it are made of brass, and are slotted at one end so as not to form complete electric circuits. If this slot were

Fig. 25. Bare Ring Armature.

Fig. 26. Armature Spider.

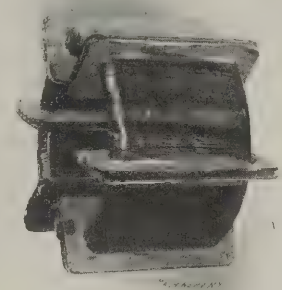


Fig. 27. Armature Ring Insulated.

Fig. 28. Armature Partly Wound.

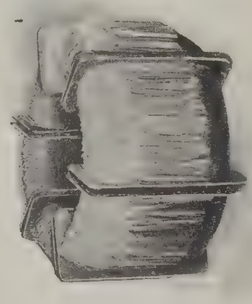


Fig. 29. Armature ready to Mount on Spider.

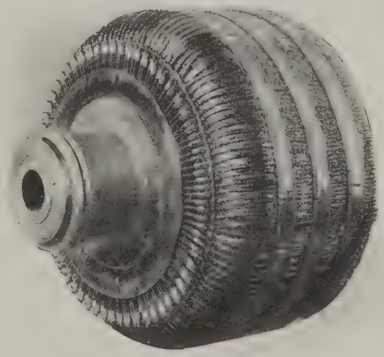


Fig. 30. Armature Complete, Commutator End.

not provided, very strong electric currents would be generated in these plates, and this would not only cause a large waste of energy, but in addition the currents would generate heat that would make the plates so hot as to cause them to burn out the insulation of the armature, and thus destroy it. The sides of the supporting plates, as well as the entire surface of the ring, inside and outside, is covered with a strong insulating material as shown in Fig. 27, generally consisting of cloth and layers of thin mica. This insulating covering is for the purpose of preventing the current in the wire from passing to the iron core or the supporting plates. When the ring is perfectly covered with the insulating layer, the wire coils are wound upon it. Each coil consists of a large number of turns of cotton covered wire, but these are wound in precisely the same manner as is illustrated in Fig. 24. Fig. 28 illustrates an armature partly wound, and shows a shuttle carrying the wire which has to pass round and round the ring. When all the coils are wound, the armature presents the appearance shown in Fig. 29. The surplus insulation is then removed and the spider is put in place, the finished armature presenting the appearance of Fig. 30 when seen from the end upon which the commutator is placed. The commutator is made up of as many segments as there are armature coils, just as in Fig. 24, and to each segment are connected the ends of adjacent coils, the same as in this simple diagram, the connections being identical in every respect. The commutator segments must be firmly supported, but at the same time they must not touch each other, nor come in contact with anything metallic. This result is obtained by separating the segments from each other by means of sheets of mica, generally about three to four hundredths of an inch thick, and the segments as a whole are held firmly clamped to a hub of cast iron, but separated from it by a layer either of mica, or a mixture of this material with cloth, asbestos or some other strong insulating material in sheet form. The way in which the segments of a commutator are held firmly, while insulated from the supporting hub, can be understood from Fig. 31, which at the upper side shows a section through the hub, the end clamping rings, and the segments. The dark shaded portion represents the layer of insulating material placed between the segments and the metallic hub and end rings.

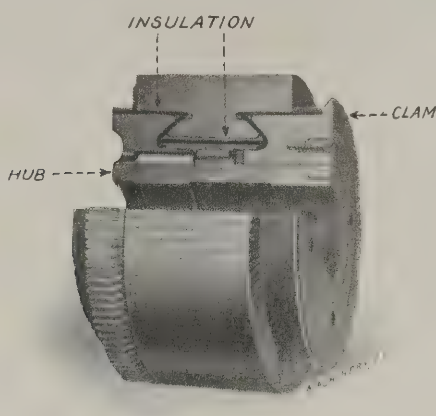


Fig. 31. Construction of Commutator.

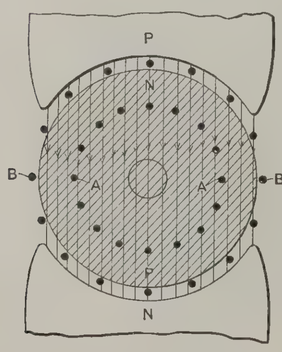


Fig. 32.

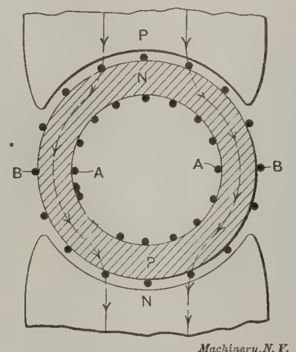


Fig. 33.

The ring upon which the wire coils are wound is made of iron, not for the purpose of obtaining a strong structure, but because if it were made of any other material, the operation of the machine would be very far from perfect. This point can be made clear by means of Figs. 32 and 33. Suppose the ring were made of brass, or wood, both of which have about as high a reluctance or magnetic resistance as air, then, in so far as the magnetic action is concerned the ring would be in the same condition as the space within it; that is, the magnetic flux would pass through the ring and then through the central space in straight lines from one field pole to the other, as indicated in Fig. 32 by the vertical lines. This being the case, the sides of the coils inside of the ring, forming circle *A*, would have E. M. F.'s induced in them just as well as the sides on the outer surface of the ring, and in both the direction of the E. M. F.'s would be the same with reference to a fixed point, say both would be toward the commutator end. This, however, would make the inside and outside E. M. F.'s, in opposition to each other, considering the wire itself; therefore, the net E. M. F. induced would be simply the difference between these two, and with a thin ring it would amount to very little. When the ring is made of iron, the magnetic flux does not pass through the center space, but flows around it, through the ring, as indicated in Fig. 33, so that there is no E. M. F. induced in the sides of the coils forming the circle *A A*, hence, the actual voltage of the generator is equal to the sum of the voltages induced in all the wires covering one-half of the armature. The voltage is only equal to the sum of the E. M. F.'s induced in the wires covering one-half of the armature, because the two halves are connected in parallel, as can be seen clearly in Fig. 24.

* * *

FAULTS OF BLOCK SIGNALS, AND A SUGGESTION FOR SAFETY.

The present system of block signals at night is ill-adapted not to the eye alone; it gives needless labor to the memory and the attention. It requires the engineer, among the innumerable lights that line his track, to distinguish those which are to guide him, from those that are of no significance to him at all. Anyone who has ridden in the cab of an express locomotive during its frantic course by night, and seen the engineer, as by a miracle, pick out his "white" signal amid a swarm of nearby city lights of a hue identical with the one that must direct him; seen him, also, with an almost mysterious confidence rush past countless red and green lights, knowing that they were not for him, but were switch-lights, or lanterns guarding the rear of some neighboring train, or were signals for "slow" trains, for cross-overs, and a host of things besides—as one dashes recklessly through this maze of colored lights, he can no longer wonder that signals are occasionally misread or unobserved. He can only marvel that a night express ever reaches its goal in safety.

Added, then, to the perils due to the defects of the eye, both normal and abnormal, the present block signals have this serious fault: they do not stand out distinct and apart from numberless other lights that suddenly appear to the engineer, but to which he is expected to give no heed.

These objections to the use of color in our block signals might perhaps be hardly worth recounting if nothing better could possibly take its place; we might regret that our own safety and the safety of our fellowmen must hang by so slender a thread, and there the matter would end. The situation, however, is not at all so hopeless. We may, whenever we please, do away with color as a means of signaling, and put in its place a better order of signs.

The plan that I would propose would be to use throughout the twenty-four hours the kind of signal which is now employed only by day. This could be accomplished simply by making at night the vane of the semaphore luminous. As, in our cities, lights are arranged in lines and letters to catch the attention, so here the signal could become a fiery arm pointing outward or down or, if need be, midway between these directions, at will. Such a line of fire would be strikingly different from the usual lights of buildings or of streets. It would also, both in quality and in form, stand out entirely distinct from all the colored lights whose use upon the railway it may, in the end, seem wise to continue for purposes other than the block signal.—George M. Stratton in *Century*.

NOVEL IDEAS IN DIE MAKING.

About seven years ago, what is now the Providence Mfg. & Tool Co. of Providence, R. I., began the manufacture of a mechanical accountant, the invention of Mr. Turck, the present superintendent of the shop. Mr. Turck's experience, so far as shop work and tool design is concerned, had not lain in the direction of die-making, so in equipping the new plant for the manufacture of the accounting machine he was at first hampered by his lack of knowledge on this subject. The die work required was of a high order. The construction of machines of this type is often such that errors are cumulative. Several similar parts are used, attached to each other in series, for instance, in such a way that if the holes by which they are riveted to each other are slightly wrong in their dimensions, the error will be multiplied by the number of parts. The machine depends for its operation quite largely on the action of pawls upon fine ratchet teeth, and on the meshing of fine pitched gears and toothed segments with each other. The effect of cumulative errors in such circumstances would be to throw these fine pitched ratchets and gears out of step, and make the operation of the machine impossible. Long leverages are also a disturbing factor. When a long, slender member is located by two rivet holes close together, it takes careful work in punching those rivet holes to bring the parts into alignment.

In Providence, when die-making is mentioned without any qualifying explanations, the making of press tools for the jewelry trade is meant, Providence being one of the greatest centers in the world for this business. On this account, when the superintendent of the new shop hired die-makers, or let die-making out to men who made a business of that class of work, he found that the work returned to him was performed in accordance with the jewelry die-maker's standards of accuracy, which were far below those required in the interchangeable manufacture of machinery of the kind he was building.

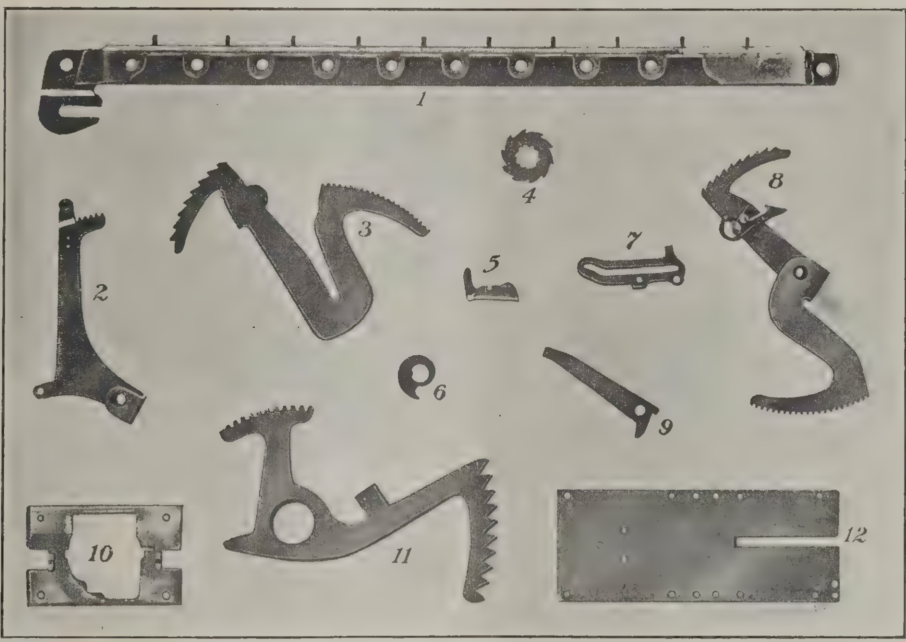


Fig. 1. Some Examples of Good Press Work.

Meeting with this difficulty in finding workmen or firms able to do his work, and being hard pressed for time, he determined, inexperienced though he was, to make a brave attempt to do the work himself, with the help of such skilled machinists as he could hire in a city where skilled machinists are not at all uncommon. The results obtained were satisfactory and even surprising, as in many other cases where men have been forced to work out for themselves the details of a business about which there is supposed to be more or less mystery. As might be expected, however, some of the methods followed are original and unusual. This article is devoted to such of these unusual and original methods as were noted by the writer in a half-day's visit.

In the halftone in Fig. 1 are shown a number of press-made parts. Some of these are interesting in themselves, while others are remarkable principally for the methods used in producing them. Part No. 12, for instance, is a very simple piece, but the punch and die used in piercing the holes, while not unusual so far as surface appearances go, will serve well to illustrate some of the original practices of this shop. This punch and die, shown in Fig. 2, perform the simple operation of punching the nineteen small holes in the blank, which is located over die *A* by the carefully fitted aperture in jacket *B*. The punch is composed of a body *C*, a cast iron holding plate *D* in which the small punches *E* are driven, a stripping plate *F*, held as shown, and forced outward by the compressed rectangular ring *G* of rubber behind it.

The Construction of a Piercing Punch with a Novel Stripping Plate.

The making of this punch and die follows, in general, the order given below. Stripper *F* is first made of tool steel. The holes for the dowels *H* are next drilled. Then the holes through which punches *E* pass are laid out from model or drawing, as the case may require, and drilled to a *larger* diameter than the punches which are to pass through them. After these holes have been drilled, the plate is hardened and ground and the holes for the punches are filled up again by driving into them plugs of tool steel wire, of suitable size. The location of these holes is now laid out again on plate *F*, and this time very carefully; then they are finished to the exact size or slightly below if they are to be lapped. Since the body of the plate is hard, it cannot cave in or wear as it would if left soft. A full bearing on the stock to be blanked is absolutely necessary if the work is to be well done. The plugs allow the plunger holes to be located after the hardening of plate *F*, thereby preventing displacement from the heat treatment. To the stripper plate are now riveted the four dowels *H*, which enter holes in the stripper rim or "collet" *J*, and locate the plate. Small round-headed setscrews *K* bear on pins *H* and hold *F* and *J* together. Punch holder *D*, of cast iron, is machined to fit closely in collet *J*, and the holes for the punches are transferred to it from stripper plate *F*. The punches *E*, made of tool steel wire, are now driven into the holder, headed over at the back side, and ground flush. The punches may then be hardened in the usual manner. Before being assembled on the punch body *C* with the rubber spring *G*, a hardened steel backing *K* is inserted between *D* and *C* to take the thrust of the hardened punches.

The rubber spring *G* is cut from sheet stock and may be made either from separate strips built up on each of the four sides of the punch, or from rectangular rings, if that can be done without wasting the stock. Screws *L* are adjusted to bring the face of the stripper flush with the faces of the punches, after which headless setscrews *M* are screwed in to make the adjustment permanent. Screws *L* may then be taken out and replaced without losing the adjustment. The punch holder *D* and pad *K* are held to the holder by screws *N* and dowels *O*.

A Piercing Die with Inserted Tool Steel Plugs for Cutting Edges.

The body *A* of the die is made of soft steel or cast iron. In this body are driven standard taper plugs of tool steel of suitable size, and so arranged as to be in position to furnish a tool steel material for all the actual cutting surfaces of the die. In the case shown in Fig. 2, nine of these plugs are used, carrying from one to three holes each. In making the recesses for these plugs standard tools are used. The seats are first

drilled nearly to size, and then finished with a tapered end mill or counterbore, which is kept carefully ground to the proper dimensions, so that when the plug is driven in until it binds tightly on the taper, it will also seat on the bottom. These various plugs *P* are prevented from turning in the holes by dowel pins *Q*, in most cases, or where the plugs run into each other (as shown in two cases in the die here described) by the interlocking of the flat abutting surfaces. These precautions make it possible to remove the plugs at any time and return them accurately to their original positions.

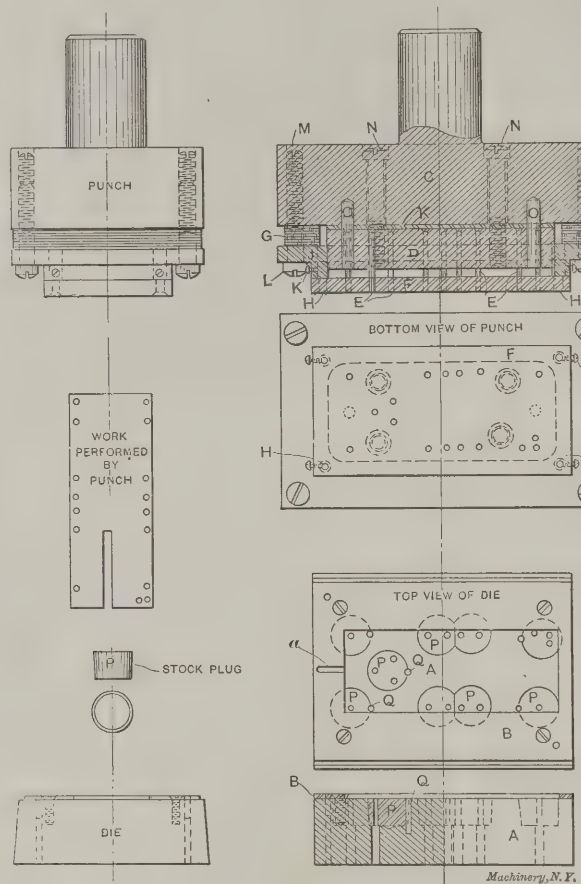


Fig. 2. A Piercing Punch and Die involving some Original Ideas.

The die plate *A* having been fitted with its plugs as described, the holes in stripper plate *F* are now transferred to it by any suitable means, all these holes being received in the tool steel plugs as explained. The plugs may now be removed, to be hardened and lapped separately. The clearance holes for the scrap are drilled, and the plugs are returned to their proper places. The jacket *B*, which locates the blank on the die, may, if desired, be punched from stock of suitable thickness by the blanking die used for making the blank to be operated on in this piercing die. The edges of the opening are then merely filed enough to allow the work to enter and be withdrawn easily. A slanting groove, as shown at *a*, is cut with a round file into the jacket at one end to permit the insertion of a pick or awl to remove the work.

The points of interest in this die are: The rubber-backed stripper plate; the use of a soft stripper plate bushed in the manner described with hardened tool steel; and the insertion of plugs of tool steel in a soft die block to form the cutting edges of the die.

The rubber spring has proven very satisfactory. It will last for a number of years in dies having ordinary use, if it is not exposed to oil and other deteriorating influences. Being in the upper member, there is little likelihood of its being spoiled in this way. The use of this stiffly spring-supported stripper plate gives a punch and die of the design shown all the advantages of a sub-press, so far as concerns the ability to punch small holes in thick material and leave thin walls of metal between open spaces in the punching. As evidence of the ability to do work of this kind with a punch and die of the style just described, parts 7 and 10 in Fig. 1 may be particularly noted. Here the holes are considerably smaller in diameter than the thickness of the stock, and the internal spaces have been punched so close to the edge, in places, that the remaining section is narrower than it is thick.

The method of bushing the stripper plate by drilling the holes large originally, plugging them with tool steel wire after hardening, and redrilling them to the proper size, makes it possible to harden the surfaces in contact with the work, without distortion of the dimensions between the holes. Plates of large size, even, are made in this way.

The advantage claimed for the method by which the stripper plate is made, may also be claimed for the use of hardened plugs in a soft die body, since it is possible to harden these parts individually without changing their location with reference to each other. In addition, both of these schemes allow changes to be made in the dies with a minimum of trouble and expense. If it is desired to change the location of a hole in the die, the old plug may be removed and a new one inserted. In the same manner new holes may be drilled in the stripper plate in which new tool steel wire plugs may be driven for new guiding holes for the punches, although the change is limited by the size of the plugs. This consideration is of considerable importance if the parts manufactured are subject to improvement from time to time. This provision reduces the expense of spoiled work as well, since it is not necessary to throw away an expensive press tool if one or two of the holes are wrongly located.

Rubber-backed vs. Sub-press Dies.

It will be noted that part No. 12 in Fig. 1 (for which the punch and die just described were designed) is made in three operations. Under ordinary conditions, it is the belief of Mr. Turck that this procedure is preferable to the use of the sub-press. The rubber spring supported stripper plate, as just described, gives all the advantages of the sub-press, so far as ability to do fine work on thick stock is concerned. Slender punches are supported by the stripper in the same way as with the sub-press; the rubber spring holds the stripper so firmly on the work that the distortion of thin stock is prevented. The sub-press certainly has the advantage of ease of setting in the machine, since it is not necessary to carefully line up the punch and die, which are in permanent alignment. It is possible, however, that the high initial cost of the sub-press would in many cases more than pay for the extra wages of an experienced and careful man in setting tools up during the lifetime of the punch and die. It must also be admitted that work cannot be done as rapidly with the three sets of tools necessary for making the piece in the manner here described, as would be possible if a sub-press were used. The saving in first cost, however, and in the cost of subsequent operations, is believed to be sufficient in the case of the Providence Mfg. & Tool Co. to show a balance on the right side of the sheet for the simpler form of press tool. It should be said in this connection that this firm freely makes and uses the sub-press die, both for customers and for their own work.

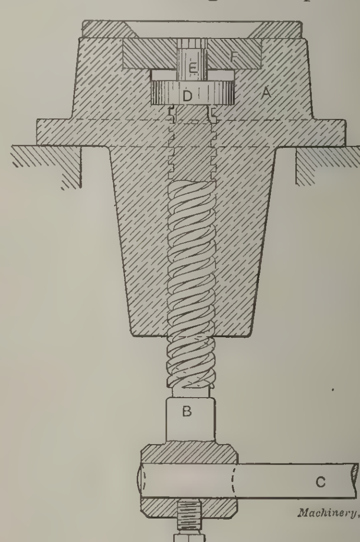


Fig. 3. Die for Bringing Up Drawn-down Corners.

The Thickening of Corners Drawn Out in Blanking.

An operation that interested the writer was a coining process used for reshaping the points of gears, ratchets, etc.—such parts, for instance, as are shown in samples 4 and 6. In such a piece as No. 4, whatever the design of the die, the blank produced will be found to have the points drawn down

thinner than the stock thickness. To bring the part back to uniform thickness with sharp points, the device shown in Fig. 3 is used. Here we have an attachment to a hand screw press. The body A is fastened to the bed of the press. The screw B projects through the bed and carries at its lower end a handle C, which is adjusted to one side or the other to bring it in position to be swung by the foot of the operator. In a counterbore in body A is seated the plug D and the ejector E. D and E are forced upward by the action of screw B. At F is a die, given the shape desired for the outline of the finished part; it is slightly enlarged, however, for a short distance at its upper end. The part as it leaves the blanking press is purposely made a little large in outline at the points where the thinning occurs, due to the drawing out of the stock. When the piece is inserted by the operator in the upper end of this tapering die, the extra metal thus provided is forced inward to thicken the points to the required amount as the punch is brought down upon the work by the hand of the operator. When the piece has been forced to the bottom, it is clamped between the plane surfaces of ejector E and the punch above it (not shown), and the metal is forced to flow to that part of the blank where it is most needed. The result is a flat ratchet with plane faces and uniform thickness. It will be understood, of course, that during this coining operation ejector E and plug D seat in the counterbore in body A, screw B being lowered out of contact. A push of the operator's foot on handle C brings the ejector up again until the piece is forced out of the die. The thread of the screw is of such a steep pitch that it will return again by its own weight.

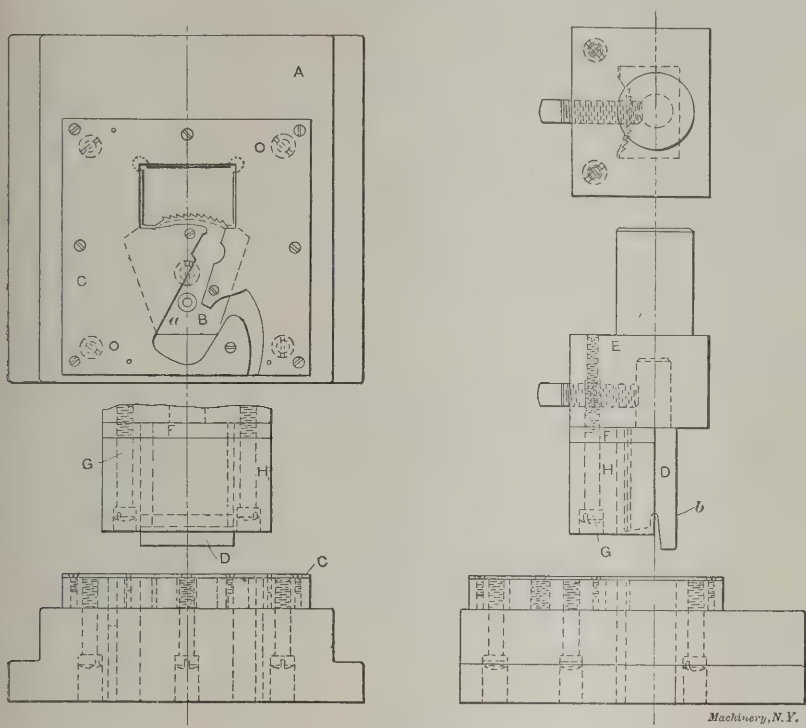


Fig. 4. Example of Type of Die used for Shaving.

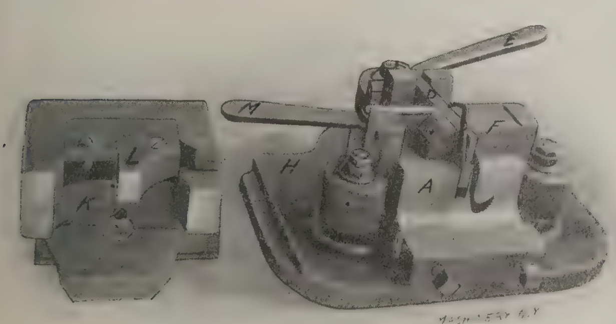


Fig. 5. Bending Attachment with Removable Die. Operation Completed.

The comparative slowness of operation resulting from the use of a hand and foot power press and hand feeding is, in a measure, characteristic of the shop. It is the belief of the superintendent that better results can be obtained at times by methods like that shown than by more "modern" ones. The aim is, through careful workmanship and careful inspection, to have the parts so nearly right when assembling time comes, that no fitting will need to be done in the assembled machines. No fitting is, in fact, allowed. Certainly the method described for striking up the corners of these ratchets is a much less dangerous one than would be the case if a power press were used, so the idea has its advantages, so far as safety is concerned, at least.

A Typical Shaving Die.

In such parts as are shown at 3 and 11 in Fig. 1, the ratchet teeth and gear teeth are only roughed out in the blanking die, being finished by a second cut or "shaving" process. A typical die and punch for this operation are shown in Fig. 4. Here, as in Fig. 2, the work is held by a rubber spring backing while the punch is at work. The die is made of a soft body A, in which is inserted the hardened piece B carrying the cutting edges which are to form the ratchet teeth on the work. This piece B has its teeth cut on it in the milling machine, the hole at a serving to center the piece for this operation. This gives assurance that the teeth will be properly spaced and cut accurately to the proper radius. A rectangular opening with carefully machined sides is made through the die block A. Into this opening the toothed cutting edges of piece B project. As in Fig. 2 a "jacket" C is provided for locating the work over the cutting die. The punch D is set into a holder E, which in turn is fastened in the ram of the machine. A projecting guiding surface, b, on the punch, enters the rectangular opening in the die and bears against it on the back and sides. This keeps the cutting surface of the punch up to its work against the cutting edge of the die. As shown, the cutting edge of the punch is beveled. This gives a slight top rake to the edge and produces a shearing cut as well, the outer corners coming into action before the center of the outline reaches the stock. The rubber spring backing at F is held by screw G between the pressure block H and the punch holder E. It performs the same functions at the stripper plate in the other die.

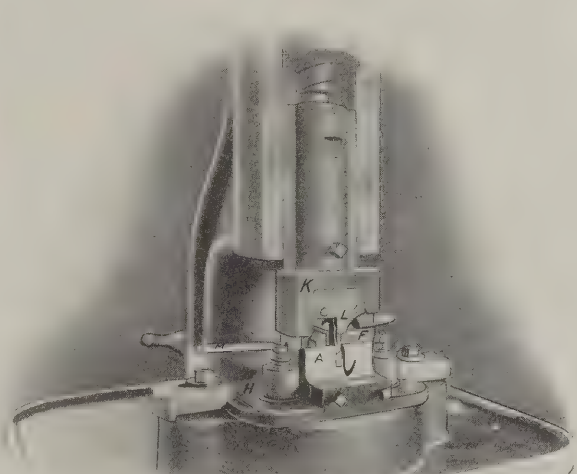


Fig. 6. Bending Device in use in Screw Press.

Bending Punchings to Provide Double Bearings.

It will be noticed that samples 1, 5 and 8 in Fig. 1 have been made on the principle of bending the punchings to give a double bearing at pivotal points, the long bearing insuring lateral steadiness of the part without making it necessary to resort to the use of castings with long hubs. This principle is carried out throughout the calculating machine which is this firm's principal product. In some cases, especially where the pivot holes are punched previous to bending, as is the case

in sample 8, very accurate work must be done in the bending to bring the part to exactly the right form. In the sample referred to, for instance, the ratchet teeth on one side and the gear teeth on the other must bear a definite relation to each other, and to the axis about which the part rotates. The bending tools by which the forming operation is performed for this part are shown in the halftones in Figs. 5 and 6 and the line cut Fig. 7. Referring to Fig. 7, the blank for part 8 (shown at No. 3 in Fig. 1 before the piercing of the pivot holes) is laid on top of former *A*, where it is located by the pins *B B* which enter the pivot holes. In this position the part lies between the fixed jaw *C* and the movable jaw *D*, which are then clamped together on the blank by bringing handle *E* to the position shown, where its wedge-shaped cam surface *b* has entered between the long ends of the jaws *D* and *C*, and brought the outer ends together. The jaws *D* and *C* and lever *E* are all attached to the holder *F*, which is a sliding fit on three vertical posts *G*, fast to the base *H* of the fixture. Slide *F* is held to the upper extreme of its travel against the lock nuts and washers at the top of posts *G* by spiral springs *J* at each post. These parts are shown to good advantage in the halftone, Fig. 5. *K* is a plunger mounted in the ram of the press. It bears on finished projections on slide *F* at three points as shown, while the hardened part *L* bears on the top of lever *D*, directly over the work. When *K* and *L* strike slide *F* and lever *D* in their descent, they carry with it the slide and its attached levers, and the work as well, against the slight resistance of springs *J*. The work grasped between the levers is thus carried down through the opening in die *A*. This action serves to bend the part to the form desired. Fig. 6 shows the operation completed. As shown, this work is done in a hand screw press. This is another example of manufacturing methods which at first sight seem rather crude, but which have proven, in the opinion of the superintendent of the shop, to be most satisfactory, his contention of greater accuracy and more uniform results from such methods applying particularly in the case of forming operations of this kind.

The piece is ejected from the tool at the completion of the bending by lever *M*, which thrusts forward the ejector *N*. This ejector is at its working end slightly less in thickness than the stock of the punching operated on, and is thus able to enter freely between the jaws and eject the work. In this tool, members *A*, *C* and *D* are changed for different parts, the rest of the structure being the same and serving for a number of different operations.

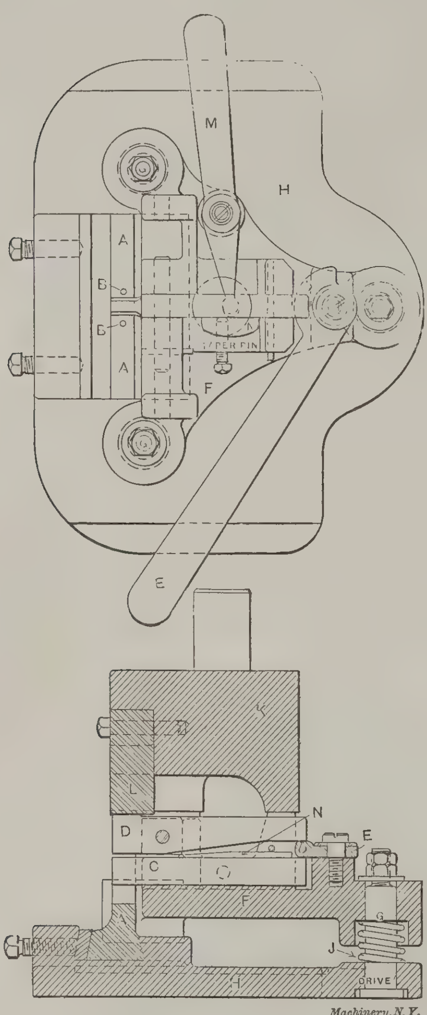


Fig. 7. Construction of Bending Attachment.

A Die for Double Punching.

In the case just described, where double bearings occur, the holes are punched before bending. This is not always the case, however. In samples 1 and 5 in Fig. 1, the parts were first bent and then punched, the operation being performed in a very interesting way. The punch descends and makes the hole in the upper thickness of the stock. Continuing through an intermediate die, and carrying before it the punched-out stock, it arrives at the second or lower thickness of stock. The continued movement of the punch then presses the little plug of punched-out metal through the lower thickness of stock, and this forms the second hole. Strange to say, it has been found in practice that this second hole is generally the better one of the two, even though it is made with a soft plug of steel instead of with a hardened punch.

The line cut Fig. 8 and the halftone Fig. 9 show the double punching tools used in making the pivot holes in sample 1, Fig. 1. This, it will be seen, is a progressive operation, all the parts in the lot being punched for one of the holes, after which the die is altered and the next hole in order is punched in all of the parts—and so on. The piece to be operated on is located lengthwise by slipping it over a gage pin in sliding block *A*, which may be adjusted to any position on slide *B* to suit the hole it is desired to punch at the time. Being located on block *A* in the manner described, it is swung around until the intermediate die *C* enters the channel formed by the two sides of the work. Cam lever *D* is then swung to the position shown in the line cut, where it has brought clamp lever *E* against the stock, holding it firmly in position for the operation. The punch *F* is a simple turned piece of hardened steel, held by taper pin in punch holder *G*. It is surrounded by a stripper *H* which is screwed to a holder *J*, backed by the usual rubber spring at *K*. This serves to hold the work firmly during the operation, and strip the work from the punch when it returns to its upward position. As before described, the punch in its descent breaks through the upper thickness of stock, carries the plug of soft metal thus formed before it until it comes in contact with the lower thickness, where it forces the plug through and forms the lower hole. It will be noticed that intermediate die *C*, though held firmly so far as displacement horizontally in any direction is concerned, is yet provided with a rocking face where it bears on the body of the die *L*. This arrangement takes the strain of the punching from the slender intermediate die, which is thus bent downward until it is firmly supported by the stock of the part being worked on beneath it. For removing the work after the operation, an ejector *M* is provided, with a handle *N*, which operates in a way which will be easily understood from an inspection of Fig. 9. It is not shown in Fig. 8, having been added at a date later than the drawing from which this cut was made.

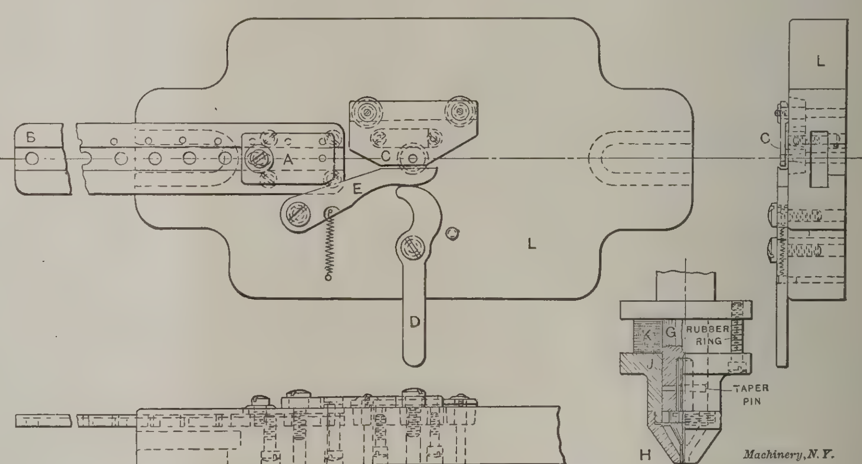


Fig. 8. Construction of Die for Double Punching.

Practice in Hardening Punches, Etc.

Blanking punches are hardened in this shop in a way that is originated here and not practiced elsewhere, so far as the writer is aware. After the plunger of a blanking die has been cut into the female portion of the die, and finished ready for hardening, it is placed in the fire and brought to a slightly lower heat than ordinarily used for hardening clear through. Cyanide is then deposited on the parts of the tool to be hardened—that is, on the periphery of the cutting edge. It is allowed to "soak in," it sometimes being necessary to apply cyanide two or three times, depending on the size and bulk of the plunger. It is then again brought to the proper heat, which should be a little lower than is ordinarily used for hardening clear through. Then it is quenched in oil. With

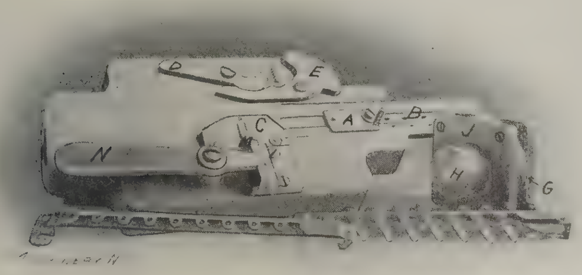


Fig. 9. Double Punching Die shown in Fig. 8.

large and bulky pieces it is first necessary to immerse the work in water as a preliminary cooling operation. This immersion should merely be a dash into the water and out again, after which the piece is put into the oil until cooled.

It is to be understood that this cyanide-hardened punch is made of tool steel of the ordinary grades used for punches. The treatment is such that only the exterior skin is hardened, where the cutting action takes place as the edge is ground down from time to time; the rest remains soft and strong, able to withstand very hard usage. But the great advantage is that the parts are not drawn out of shape by this heat treatment, since only a very small portion of the metal is hardened.

It is not feasible to use this cyanide process for hardening female dies for purposes other than blanking soft brass parts. As the blanks are pushed into the die, there is a swaging process taking place which would force the walls out if they were case-hardened; it is therefore necessary to harden clear through. Where the outlines are intricate and delicate, however, the shrinkage is so small that in most cases there would be no necessity for this. In any event the plunger or punch would be made whole, and cut into the die. The plunger would then be hardened by the cyanide process, and would not be thrown out of shape, but would drop through the die as nicely as before the heat treatment. It is thus seldom, if ever, necessary to make the plunger in sections.

As remarked at the outset, the novel points in die making practice to be seen at this shop are to be explained by the fact that the methods used there are the result of studying the problem of die-making from original experience, without much to build on in the way of second-hand knowledge, or traditions of others. The workmen here have been educated in tool-making in the shop itself, and few of the better ones, at least, were tool-makers at the time they came. This is evidently another example of the truth that it is possible for determined and intelligent men to start out in an unknown field in the study of subjects about which there is popularly supposed to be something of mystery, and still do things worth while, and even be able to add something original of value to the practice of the art. As evidence of this firm's success, it may be said that a large and increasing part of its business consists in the design and construction of dies and special tools for other manufacturers. R. E. F.

* * *

Do not wrap paper around an incandescent electric lamp for a shade. A fire might easily be started from the heat

THE CARD INDEX IN THE JOBBING SHOP.*

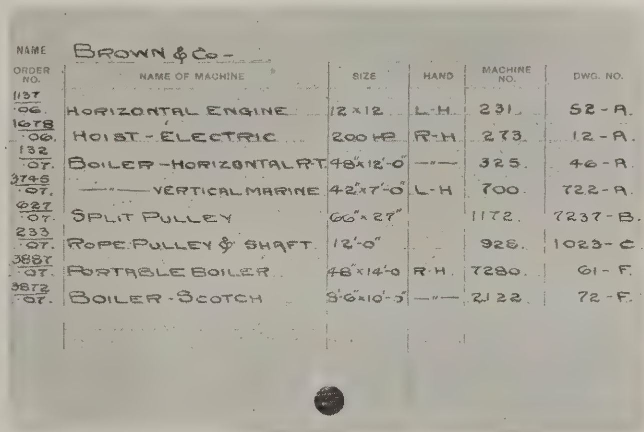
J. S. WATTS.†

The writer has charge of a shop doing a general line of repair work and some building of new machinery, in a place where there is little scope to take up any standard line of work or even to make the same machine twice without alteration. To avoid endless confusion he has found it necessary to evolve some system of keeping records of the machines and parts of machines sent out, and has written this article describing the system, in the hope that it may prove useful to some other superintendent in a like position.

In most shops of this kind a part of the work is done to blue-prints or sketches supplied by the customer, and part to drawings made by the firm's own staff; and the patterns are sometimes the customer's property and sometimes the firm's. The remainder of the work is repairs, overhauling, refitting, etc., of which no record need be kept. The problem resolves itself into these requirements: First, to be able to find at any time the drawing to which any part of any machine was made, given the customer's name. Second, to have a complete index to all patterns, drawings, foreign blue-prints, etc., to save duplication of any of these where they can be worked in on another order.

On receipt of an order from a customer it is written out on a form, a copy of which goes to the drawing office, pattern shop, boiler shop and machine shop, or such of these departments as have work to do on that order.

We will suppose that this order is for a machine to be made to the firm's own drawings. The drawing office then, on receipt of this order, makes out a production sheet on bond paper forms, giving name and number required of each part, drawing number, pattern number if a casting, and material of which it is made. This production sheet should include everything required, bolts, nuts, oil-cups, gaskets, split pins, nameplate and every detail, no matter how small. In the case of forgings it should give in addition to drawing number, the length and size of bar required to make it. The required number of prints should then be made from the production sheet,



NAME Brown & Co –

ORDER NO.	NAME OF MACHINE	SIZE	HAND	MACHINE NO.	DWG. NO.
1137/06.	Horizontal Engine	12×12	L-H.	231.	52-A.
1678/06.	Hoist – Electric	200 HP	R-H	273	12-A.
132/07.	Boiler – Horizontal R.T.	48″×12′-0″	—″—	325.	46-A.
3745/07.	——″—— Vertical Marine	42″×7′-0″	L-H	700.	722-A.
627/07.	Split Pulley	66″×27″		1172.	7237-B.
233/07.	Rope Pulley & Shaft	12′-0″		928.	1023-C.
3887/07.	Portable Boiler	48″×14′-0	R-H.	7280.	61-F.
3872/07.	Boiler - Scotch	8′-6″×10′-5″	—″—	2122.	72-F.

Fig. 1.

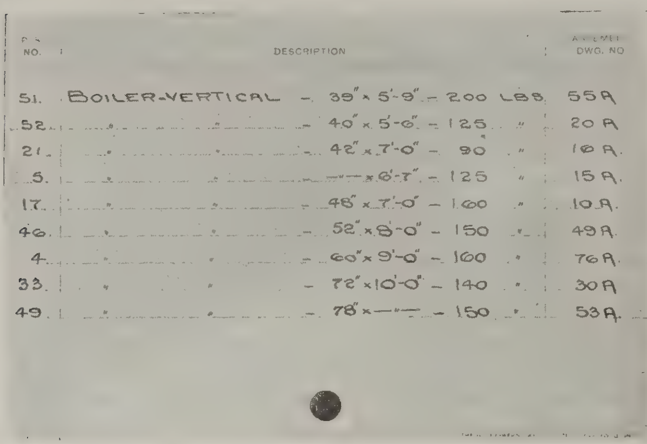
and the order number, name of customer, date issued and number of machines required (the production sheet should always be made out for one machine only) put on the prints and not on the original as this may be used again later, on other orders. One print should then be sent to the stores department, to order the material from, and one to each of the different departments having work to do on that order, the pattern shop having to issue the patterns and orders to the foundry department. Also one print should be filed away as a record under the order number, preferably in an envelope, together with any special specification or other matter referring to that order only; these will be kept in numerical order and should be stored in a fireproof room, but, in a convenient place for reference. The original could now be altered to suit any future orders or improvements in design without affecting our record of that order. Any alterations to the drawings for

* For previous articles on shop card index systems see MACHINERY, November, 1903, The Card Index in the Drafting Room; September, 1905, Index System.

† Superintendent of I. Matheson & Co., Ltd., New Glasgow, Nova Scotia.

subsequent orders are made in such a way that we have a record of the original dimensions. However, this matter is outside the scope of this article.

Now to duplicate any part of an old order, we have a card index of the production sheet prints that are filed under their order numbers. These cards are indexed alphabetically under the customer's name; a copy of the card is shown in Fig. 1.



NO.	DESCRIPTION			DWG. NO
51.	BOILER-VERTICAL	– 39" x 5'-9"	– 200 LBS.	55 A
52.	" "	– 40" x 5'-6"	– 125 "	20 A
21.	" "	– 42" x 7'-0"	– 90 "	16 A.
5.	" "	– " x 6'-7"	– 125 "	15 A.
17.	" "	– 48" x 7'-0"	– 160 "	10 A.
46.	" "	– 52" x 8'-0"	– 150 "	49 A.
4.	" "	– 60" x 9'-0"	– 160 "	76 A.
33.	" "	– 72" x 10'-0"	– 140 "	30 A
49.	" "	– 78" x – " –	– 150 "	53 A.

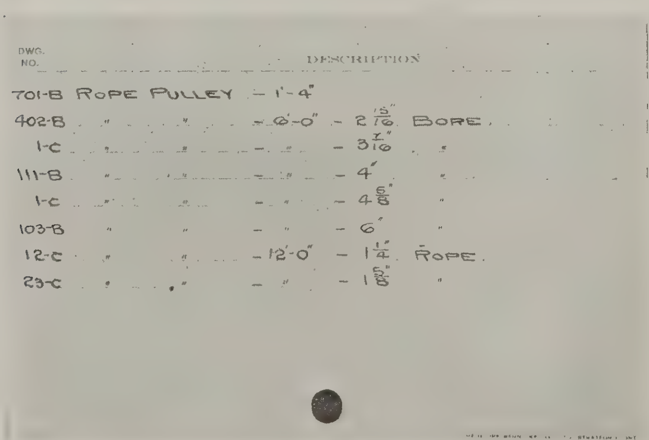
Fig. 2.

This card is filled out for each order for that firm and filed away in the index cabinet. Therefore, given the customer's name, we can by consulting this index find the order number under which his machine was built, and by getting out the production sheet print for that order number we get the drawing numbers we require.

The columns for size and hand save us the necessity of looking up two or three production sheet prints, as for instance if we get an order for a set of grate bars, same as supplied by us, with a 48-inch boiler, for Brown & Co., we look under Brown for Brown & Co.'s card, and then down that card till we come to a 48-inch boiler, which will give us the order number, and from the production sheet print for that order number we can get the pattern number and number required. If we had not the size on the card we might have any number of boilers built by us for that firm to look up in the production sheet prints before we found the 48-inch size.

The Machine No. column is used in case a customer sells his machine to some one else, the number being stamped on the name-plate of the machine.

The Drawing No. column gives the assembly drawing number, and may save time if one wanted only an assembly drawing, but it is primarily intended for orders such as stacks, smoke connections, etc., which only require one drawing. No production sheet is made for such orders, a bill of material on the drawing giving all information required.

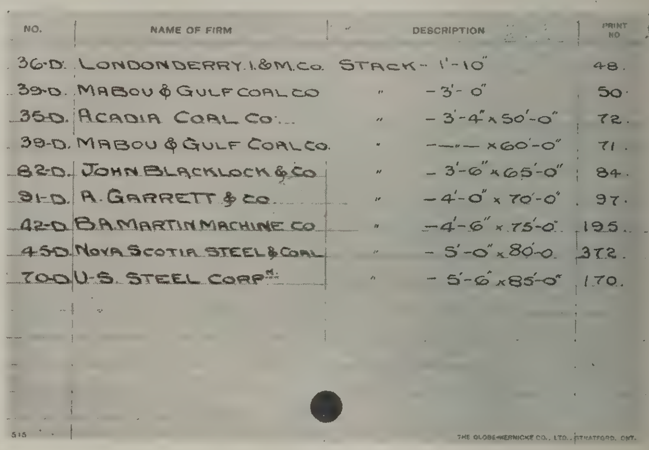


DWG. NO.	DESCRIPTION			
701-B	ROPE PULLEY	– 1'-4"		
402-B	" "	– 6'-0"	– $2\frac{15}{16}$"	BORE.
1-C	" "	– "	– $3\frac{7}{16}$"	"
111-B	" "	– "	– 4"	"
1-C	" "	– "	– $4\frac{5}{8}$"	"
103-B	" "	– "	– 6"	"
12-C	" "	– 12'-0"	– $1\frac{1}{4}$"	ROPE.
23-C	" "	– "	– $1\frac{5}{8}$"	"

Fig. 3.

The original production sheets have a card index with alphabetical guide cards, and are indexed under the name of the machine, as boiler under B. A copy of these cards is shown in Fig. 2. The production sheets are numbered in order, as made. Our own drawings are indexed alphabetically under the name of the part. These drawings are numbered and filed consecutively as made, and are given the suffix A or B. A is the large size (18 x 24-inch) and B the small size (9 x 12-inch). The A and B drawings are numbered and filed independently of each other. The cards for indexing these drawings are shown in Fig. 3. Each part of a machine is on a separate card, and the cards are re-written from time to time to keep the parts on the card in order of size, smallest size at top, as other similar parts of different sizes are made and interpolated.

If the order should be to make a machine to the customer's blue-prints we number these prints consecutively, starting with the number after that given to the last blue-print on the previous order, and giving it the suffix *C* or *D*, as 125-*C*. The suffix *C* indicates that the patterns shown on that print are our property, and the suffix *D* indicates the reverse. These prints are folded and put in envelopes bearing the same number, and are filed away in consecutive order, the *C* and *D* prints being in separate drawers. The *C* prints are indexed with our own *A* and *B* drawings, so that we have on the cards a complete list of all sizes of patterns or designs we have of that particular part. The *D* prints are indexed under the name of the part, the card being shown on Fig. 4. The column for print number is for the number given the print by the customer, and Name of Firm is the name of the customer or owner of the print; these two columns are for purposes of ready identification.



NO.	NAME OF FIRM	DESCRIPTION	PRINT NO
36-D.	LONDONDERRY I. & M. Co.	STACK – 1'-10"	48.
39-D.	MABOU & GULF COAL CO	" – 3'-0"	50.
35-D.	ACADIA COAL CO.	" – 3'-4" x 50'-0"	72.
39-D.	MABOU & GULF COAL CO.	" – " x 60'-0"	71.
82-D.	JOHN BLACKLOCK & CO	" – 3'-6" x 65'-0"	84.
91-D.	A. GARRETT & CO.	" – 4'-0" x 70'-0"	97.
42-D.	B. A. MARTIN MACHINE CO	" – 4'-6" x 75'-0"	195.
45-D.	NOVA SCOTIA STEEL & COAL	" – 5'-0" x 80'-0"	372.
70-D.	U. S. STEEL CORPN.	" – 5'-6" x 85'-0"	170.

Fig. 4.

The foregoing is only a bare outline of the system, but it will be sufficient to show its cheapness and adaptability to the work required of it.

* * *

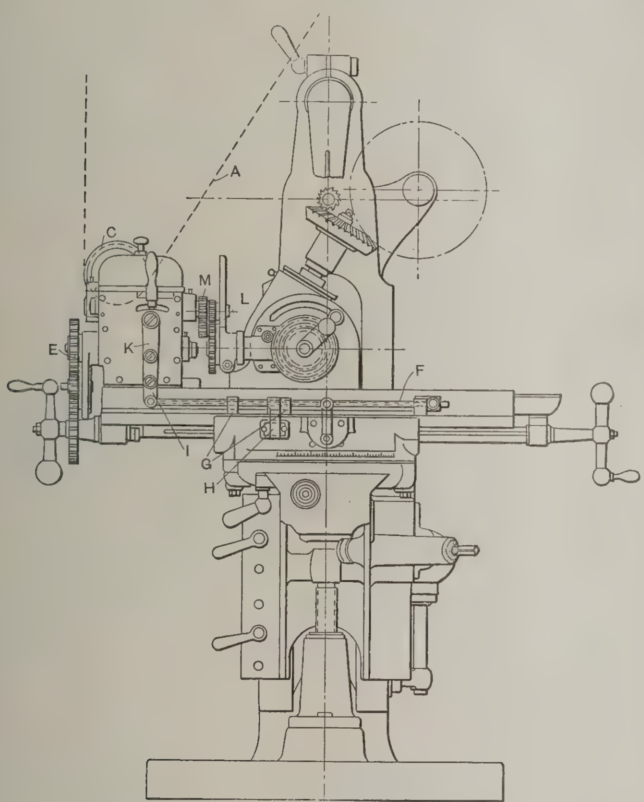
TO IMPROVE IGNITION IN COMBUSTION MOTORS

A weakness of the internal combustion motor is the ignition, and although the changes of design in recent years have greatly improved this feature there is still much to be desired. Electric ignition of the jump spark type has generally displaced the make-and-break form, which in turn succeeded the hot tube. But the jump spark has a high voltage and requires the very best insulation. Recent investigations of the causes for failure of electric ignition have resulted in some interesting disclosures. It was demonstrated that a spark plug insulated with porcelain might cause failure, when highly heated, by the electric current leaking across the insulation. The principle of the Nernst lamp depends upon the fact that porcelain at ordinary temperatures is an excellent non-conductor of electricity, but when heated red hot the resistance drops to less than one-thousandth of the cold resistance, and the same condition apparently exists sometimes in the spark plug of the gasoline engine. One means of overcoming this defect is the introduction of an external spark gap as well, as this tends to prevent leakage across the porcelain when the latter becomes highly heated. When the timer makes contact, the rush of current will be sufficient to cause a spark between the internal points, notwithstanding the increased conductivity of the porcelain. It is suggested that trouble of this order might be avoided by more care being taken to keep the ignition plugs cool by judicious arrangement of the cooling water circulation.

AUTOMATIC INDEXING AND FEED ATTACHMENT FOR THE MILLING MACHINE.

As another indication of the activity of European machine tool builders in the matter of designing new machinery and attachments, we present herewith a line cut and description of an ingenious milling machine attachment recently developed by Ludwig Loewe & Co., of Berlin, Germany. The device is intended to be attached to the table of the makers' regular line of universal milling machines. Used in connection with the index head, it feeds the table forward at a suitable rate for a cutting feed, withdraws it with a quick return ratio of 8 to 1, indexes the work, feeds it forward again—and so on. In effect, it makes of the universal milling machine an automatic gear cutter for either spur or bevel gears.

The device consists of an attachment mounted at that end of the table usually occupied by the spiral head. It is driven from a special pulley on the countershaft, provided with an idler for taking up slack in the belt, and thus allowing the table to be moved to any convenient position without slackening the drive. This attachment is connected to the feed screw



Automatic Gear Cutting Attachment for the Milling Machine.

of the milling machine by change gears *E*, which are selected to give the desired feed. Being connected in this way, the usual feed motion of the machine cannot be used. The attachment is also connected to the spiral head by change gears *M*, which are selected to give the required indexing for the number of teeth desired. Lever *K* operates the feeding, reversing and indexing mechanisms. This lever is shifted automatically by adjustable dogs *G*, which strike stop *H*, at the limits of the movement of the table in either direction. These dogs are clamped to rod *F*, which in turn is pivoted at *I* at the lower end of lever *K*. With the machine properly adjusted, the work will be fed forward slowly until the rear dog *G* strikes the stop, when the shifting of the lever *K* thus brought about will reverse the mechanism and rapidly return to its starting position, determined by the striking of the other dog against the stop. The indexing then takes place, and the forward feed is started again. To avoid lost motion and unnecessary mechanism, the usual index plate and crank may be replaced with a device which clamps together the plate and index worm spindles.

The attachment is intended for such work as spur gears, bevel gears, and similar parts which do not require that the work itself revolve while the cut is being taken. The device can be reversed so that the direction of the forward feed and quick return will be changed, in which case the cutter may be run left- as well as right-handed. Special change gears are not necessary, as the regular outfit belonging to the machine can be used. While the attachment was originally designed for machines built by the makers, it can be placed on millers of other makes if they have about the same dimensions for the table and have an index head on the left side. With certain modifications it may be applied to any type of miller.

This device is another evidence of the originality and ingenuity which have characterized recent European machine tool design.

* * *

INDUSTRIAL TESTING LABORATORIES IN GERMANY.

One of the main reasons why Germany has in recent years risen to such a supremacy in engineering matters depends undoubtedly to a great extent upon that there have been established in that country from time to time various testing laboratories maintained at public expense. These investigate technical problems and publish the results so as to thereby benefit the greatest possible number of German manufacturers. While there is no doubt that there has been a great deal of experimental work undertaken in this country, these experiments have, with few exceptions, been carried out by private individuals or firms who have jealously guarded the results of their investigations, regarding them as assets in trade and terming them trade secrets. For this reason the same investigations are often carried on in a large number of different establishments, and considering the nation as a whole, a large amount of work is wasted, inasmuch as if these experiments had been carried on at a general central station, all the various firms would have been equally benefited by the results, with only a fraction of the expense to the nation as a whole. The latest German institution aiming at decreasing the cost of individually conducted experiments is reported to be a large chemical laboratory which will probably be located in the vicinity of Berlin. The initial expense will be $400,000, and the government will probably advance the money needed for keeping the institution working along such lines and in such a way as to give the greatest possible impetus to German chemical industries. The new institution, it is hoped, will work in close cooperation with the factories themselves, and will for industrial purposes supersede the chemical laboratories of the various German universities and colleges, the object of which, it is argued, should be principally educational, and be totally different from that of the contemplated institution which is intended to become the center of chemical research in Germany. It is evident that movements of this kind are far easier to inaugurate in European countries, where there is a strong centralized government considering as its duty to deal with problems of this kind, but there are no doubts that if it would be possible for certain industries in this country to unite and support some kind of a general research laboratory, a great saving would be effected in the long run, and the progress of our industries would be assured in a far greater degree than when individual persons or firms are carrying on their own experiments, often with little or no system.

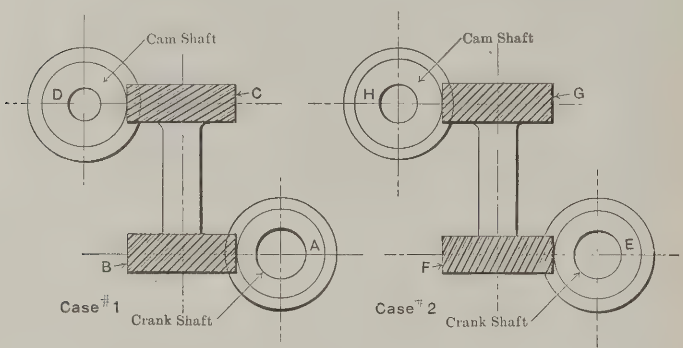
* * *

One of the most noteworthy indications of the supremacy given to military matters in Europe is the common practice on the Continent to have all important railway bridges provided with means for rapid destruction in case of necessity for this in time of war. It seems as if it would be almost discouraging for a designer or builder of such a structure to incorporate such details in his design and work, as will at a moment's notice transform the work of years, as it may be at times, into so much scrap. But this is the price paid for the glory of belonging to a military nation. The works of peace that would have to be sacrificed in a war in the territory of any of the most advanced nations, at the present time, are so tremendous that we can hardly imagine that ever two nations would dare to encounter the loss, if they were to meet on their own territory.

A COMPARISON OF THE EFFICIENCY OF TWO TRAINS OF SPIRAL GEARS.*

A correspondent who signs himself "Minne, England," has sent in the sketches and data shown in Fig. 1. He says, "Here are two different sets of spiral gears for gas engines. In each case the cam shaft runs at half the speed of the crankshaft. I should like to know which is the better arrangement for efficiency and wearing qualities, taking into consideration the nature of the work the drive has to perform, *viz.*, a single cylinder gas engine working on the 'Otto' cycle."

The answering of the question asked by our correspondent involves a little work along the line of resolution of forces and the calculation of efficiency; it is entirely elementary, but interesting nevertheless, as a practical illustration of the



	Angle of Teeth with Axis	Diameter of Pitch Circle	Number of Teeth
A	45°	4″	20
B	45°	4″	20
C	63°–26′	4″	10
D	26°–34′	4″	20

	Angle of Teeth with Axis	Diameter of Pitch Circle	Number of Teeth
E	63°–26′	4″	10
F	26°–34′	4″	20
G	45°	4″	20
H	45°	4″	20

Machinery N.Y.

Fig. 1. The Two Arrangements to be Investigated.

working of well-known principles in mechanics. For the sake, then, of their value as illustrations of the principles involved, these calculations are here given in detail.

Our correspondent asks which of the two arrangements, that in Case 1 or Case 2, is superior in efficiency and wearing qualities. It may be roughly stated that, other things being equal, the more efficient of two mechanisms is the more durable. We will consider this to be true in this case, so will examine the two arrangements for efficiency in the transmission of power. The power losses in the various journals we cannot estimate, because we do not know enough about the arrangement and design of the bearing surfaces. We can easily make an estimate for the power lost in the thrust bearings, and we may also get a comparative idea, at least, of the power lost in the rubbing of the teeth on each other, so to these losses, which are the principal ones, we will confine ourselves.

When two bodies are sliding under pressure, the power lost is equal to the continued product of the normal pressure between the surfaces, the linear velocity of the rubbing, and the coefficient of friction. To estimate the power lost at the various bearing points we are to consider, we have then to estimate these three factors for each case.

We will first estimate the relative bearing pressures at the different places where friction is met with in Case 1. To be logical we will commence our calculations at the driven end of the train of gears, since the forces in the mechanism are due to the resistance offered by the driven members. Fig. 2 is another view of Case 1 as shown in Fig. 1. Gears A and B make contact on line YZ, which represents the direction of the teeth at the point of contact; WX represents the position of the teeth of gears C and D in contact.

As gear C revolves in the direction shown, its teeth, set at the angle of the line WX, have a wedging action on those of gear D which revolves them in the direction shown. The action and the forces involved can best be understood by referring to Fig. 3. Here C is a slide moving upwards. Its beveled edge, representing the tooth surface of gear C, forces to the left of the beveled edge on slide D, which represents the tooth surface of gear D. If slide D offers a resistance to this movement, of a magnitude represented by the length of line F_5 in the parallelogram of forces shown, slide C will evidently have to exert a force equal to F_3 to overcome this resistance. The resulting normal pressure on the inclined bearing surface of contact will evidently be F_4. The end thrust or pressure against its abutment of slide D will be F_3, while that of slide C against its abutment will be F_5.

Understanding the method of applying the parallelogram of forces in Fig. 3, we may transfer the construction to gears C and D in Fig. 2. Having F_5 given, we can find F_4 and F_3 as there shown. F_3 is the tangential pressure at the pitch line required to be given by gear C to move the mechanism against the resistance F_5 offered by gear D. Since gears B and C have the same diameter, F_3 must likewise be the tangential pressure applied at the pitch line to gear B. Constructing a second parallelogram of forces for gears A and B, as shown, we find that F_2 is the normal pressure between the faces of the teeth in contact, and F_1 is the tangential force which has to be brought to bear at the pitch line of gear A to move the mechanism. Consider that F_5 equals unity (since we are after comparative results only) and measure the other forces to this scale. This can be done fully as well by calculation as by measurement. An elementary knowledge of trigonometry will give us the following results:

$F_5 = 1$

$F_4 = F_5 \div \sin \alpha_c = 1 \div 0.894 = 1.118$

$F_3 = F_5 \times \tan \alpha_d = 1 \times 0.500 = 0.500$

$F_2 = F_3 \div \sin \alpha_a = 0.500 \div 0.707 = 0.707$

$F_1 = F_3 \times \tan \alpha_b = 0.500 \times 1.000 = 0.500.$

We have next to find the rubbing velocities of the various bearing points. Fig. 4 will assist us in this. Here we have the same slides C and D, representing gears C and D in Fig. 2 or Fig. 5. If we consider that slide C is moved upward at a uniform velocity, in a unit of time it will traverse a distance equal to V_3, moving from position $g\,h$ to $g'h'$. This evidently forces slide D to the left at a uniform velocity, moving it in a unit of time from $e\,f$ to $e'f'$, a distance measured by dimension V_5. The beveled surface of slide D has meanwhile slipped on that of slide C so that corners f and h, which were in contact, have reached positions f' and h', a distance measured by dimension V_4. It is evident then that V_3, V_4, and V_5 may be taken as measures of relative velocities of the parts in question.

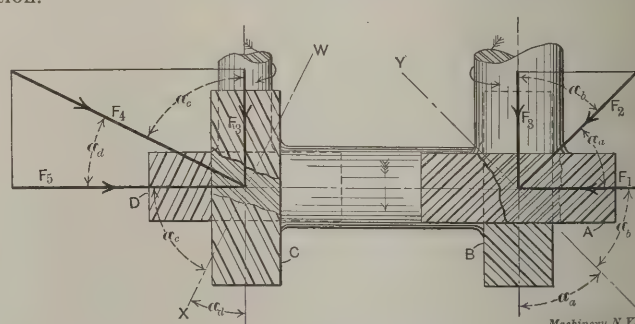


Fig. 2. Force Diagrams for Case 1.

Since the mechanism shown in Fig. 4 represents, in principle, conditions existing between gear C and D in Fig. 5, we may transfer the velocity diagram of Fig. 4 to Fig. 5, where V_5 represents the pitch velocity of gear D, V_4 the rate of rubbing at the pitch line between gears C and D, and V_3 the circumferential velocity at the pitch line of gear C. The circumferential velocity at the pitch line of gear B is evidently the same as that of gear C, since they are of the same diameter and move together. V_3 being thus known, a similar velocity diagram may be drawn for gears A and B, in which V_1 equals the velocity at the pitch line of gear A, and V_2 equals the velocity of sliding between the teeth of gears A and B.

We may, if we wish, measure these lines to the scale $V_1 = 1$ to obtain the relative velocities desired, or, better, we may derive formulas from these velocities, thus making unneces-

* For additional data on the calculation, design and cutting of spiral gears see the following articles previously published in MACHINERY: Spiral Gears, September, 1903 (Engineering Edition only); Figuring a Pair of Spiral Gears, January, 1904; Cutting Spiral Gears, October, 1905; Method of Procedure in Design of Helical Gears, May, 1906.

sary the drawing of diagrams for subsequent examples of this kind. By a simple use of trigonometrical functions, after carefully examining the diagrams, it is plain that the following relations hold true:

$$V_1 = 1$$
$$V_2 = V_1 \div \sin \alpha_a = 1 \div 0.707 = 1.414$$
$$V_3 = V_1 \times \tan \alpha_b = 1 \times 1.000 = 1.000$$
$$V_4 = V_3 \div \sin \alpha_c = 1 \div 0.894 = 1.118$$
$$V_5 = V_3 \times \tan \alpha_d = 1 \times 0.500 = 0.500.$$

The power lost in any bearing is equal to the continued product of the total pressure on that bearing, the velocity of sliding, and the coefficient of friction. We will first find the power lost in end thrust. Since our calculation is being made for comparison only and not for positive results, we will consider the coefficient of friction as being equal to 1. We will make the assumption that the mean diameter of the end thrust bearings of the various shafts is equal to half the pitch diameter of the gears. The mean velocity of rubbing will then be half the velocity of the gears at the pitch line. For the loss of power in the thrust bearing of shaft A we have:

$$F_3 \times \frac{V_1}{2} \times 1 = 0.500 \times 0.500 \times 1 = 0.250.$$

The end thrust on the intermediate shaft is that due to the difference between the opposing forces F_1 and F_5 in Fig. 2. For lost work in the end thrust of the intermediate shaft we then have:

$$(F_5 - F_1) \times \frac{V_3}{2} \times 1 = (1 - 0.500) \times 0.500 \times 1 = 0.250.$$

The loss in the thrust bearing of shaft D equals

$$F_3 \times \frac{V_5}{2} \times 1 = 0.500 \times 0.250 \times 1 = 0.125.$$

Adding these three losses together we get a total value of 0.625 as the power loss in end thrust.

For the power loss in tooth friction, we had better use a somewhat higher coefficient; perhaps 1.5 would be about right. The velocity of sliding between gears A and B is V_2, the normal pressure of the surfaces of contact is F_2. We have then for the lost power at this point:

$$F_2 \times V_2 \times 1.5 = 0.707 \times 1.414 = 1.500.$$

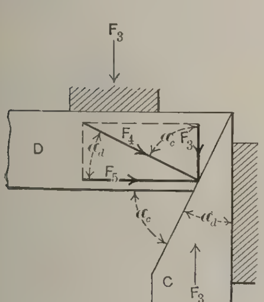


Fig. 3. Illustration of Principle Involved in Fig. 2.

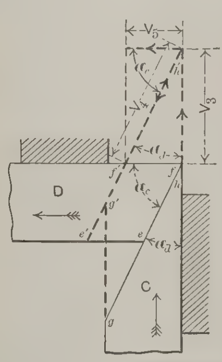


Fig. 4. Illustration of Principle Involved in Fig. 5.

Similarly the work lost between gears C and D equals

$$F_4 \times V_4 \times 1.5 = 1.118 \times 1.118 \times 1.5 = 1.875.$$

The total loss due to tooth friction is then equal to the sum of these two or 3.375, which, added to the loss in the thrust bearings, gives us 3.375 + 0.625 = 4.0, the total loss with this form of bearing.

It will not be necessary to draw new diagrams, like those in Figs. 2 and 5, for the second case, since we may use the formulas already derived for obtaining the various forces and velocities, making, however, the following substitutions. This change is in accordance with the data in Case 2.

Change α_a to $\alpha_e = 63° 26'$
" α_b to $\alpha_f = 26° 34'$
" α_c to $\alpha_g = 45°$
" α_d to $\alpha_h = 45°$.

Solving these formulas for velocities, we obtain the following quantities:

$$V_1 = 1$$
$$V_2 = V_1 \div \sin \alpha_e = 1 \div 0.894 = 1.118$$
$$V_3 = V_1 \times \tan \alpha_f = 1 \times 0.500 = 0.500$$
$$V_4 = V_3 \div \sin \alpha_g = 0.500 \div 0.707 = 0.707$$
$$V_5 = V_3 \times \tan \alpha_h = 0.500 \times 1.000 = 0.500$$

and for pressures we have the following:

$$F_5 = 1$$
$$F_4 = F_5 \div \sin \alpha_g = 1 \div 0.707 = 1.414$$
$$F_3 = F_5 \times \tan \alpha_h = 1 \times 1.000 = 1.000$$
$$F_2 = F_3 \div \sin \alpha_e = 1.000 \div 0.894 = 1.118$$
$$F_1 = F_3 \times \tan \alpha_f = 1 \times 0.500 = 0.500.$$

The work lost with the thrust bearing on shaft E equals

$$F_3 \times \frac{V_1}{2} \times 1 = 1 \times 0.5 \times 1 = 0.5.$$

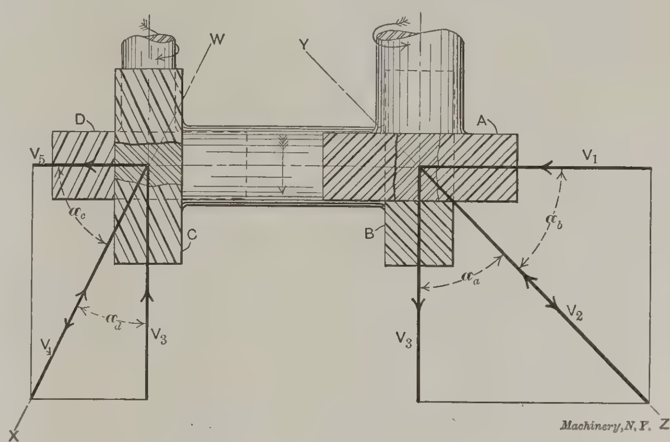


Fig. 5. Velocity Diagrams for Case 1.

That lost in the intermediate shaft equals

$$(F_5 - F_1) \times \frac{V_3}{2} \times 1 = (1 - 0.5) \times 0.25 \times 1 = 0.125.$$

The loss in power due to end thrust in shaft H equals

$$F_3 \times \frac{V_5}{2} \times 1 = 1 \times 0.25 \times 1 = 0.25.$$

These three losses added together equal 0.875.

The loss of power due to tooth friction between E and F, assuming a coefficient of friction of 1.5 as before, equals

$$F_2 \times V_2 \times 1.5 = 1.118 \times 1.118 \times 1.5 = 1.875.$$

Friction loss between G and H equals

$$F_4 \times V_4 \times 1.5 = 1.414 \times 0.707 \times 1.5 = 1.5.$$

The tooth friction loss in the tooth surfaces then equals 1.875 + 1.500 = 3.375. For Case 2 the total lost work due to tooth friction and end thrust friction equals 3.375 + 0.875 = 4.250. The difference between this quantity and the 4.000 obtained for Case 1 is scarcely large enough to "shake a stick at," as the phrase is. There is but one consideration, in fact, we can think of for preferring one construction to the other. The 45-degree gears have teeth of slightly smaller size than those of the other pair in each case, and they are therefore somewhat weaker. In Case 1, these teeth are subjected to a normal pressure F_2 of 0.707. In Case 2 they are subjected to a normal pressure F_4 of 1.414, twice as great. In Case 1, then, the strongest teeth are bearing the greatest strain, which is as it should be.

* * *

A gas plant of imposing dimensions is in course of construction at Astoria, Long Island. The *Engineering News* says that when the entire plant is finished it will spread over 400 acres of land. In this area, however, is included that necessary for the building of a large number of model homes for the employes. The six holding tanks will each have a capacity of 15,000,000 cubic feet. These tanks will have a diameter of 300 feet; they will reach down into the earth for 50 feet, and will tower above ground 150 feet. Up to this time the largest gasholding tank has been one in London with a capacity of 12,500,000 cubic feet.

REMARKS ON THE MAKING OF HAND TAPS.—1.*

ERIK OBERG.†

The following remarks, and the information and data given, are intended to supplement a number of articles on tap making which have appeared in MACHINERY during the last three years. The subject is of too great a scope to be treated in a single article or a single issue. But if the various articles that have appeared are studied collectively, these articles will be found to contain a fairly complete treatment of the subject in hand, the most complete, in fact, the writer would venture to say, that has as yet appeared in the engineering press, whether the periodical literature or that in book form is considered. While there has been a great deal written on the subject, there has not been as yet a complete compilation of the data belonging to it. For this reason it seems appropriate to add some additional information, and to bring out some points for discussion, so that the available data and the somewhat differing opinions in regard to tap making may all be recorded in such a manner that reference to them may be easy, and information readily obtained.

Requirements for Correctly Threaded Taps.

There are, in correctly threading a tap, six distinct points to take into consideration. The tap must be provided with the correct diameter in the angle of the thread, a correct outside diameter, correct lead, correct angle between the sides of the thread, correct relation of this angle to the axis of the tap, and finally correct flats or radii at the top and bottom of the threads, as required by the standard thread form. The angle diameter, for instance, may be correct while the outside diameter would be a trifle large or small, depending upon whether the flat or radius at the top of the thread were either too small or too large. The lead, of course, may be incorrect, while the other factors are practically correct. The angle of the thread may be larger or smaller than the standard angle, and if the lead, the outside diameter and the angle diameter were still approximately correct, the tap would produce a very poorly fitting thread. The angle between the sides of the thread may be correct in itself, but the thread-cutting tool may have been presented to the work at an oblique angle, thus producing a thread that would not be symmetrical about a line through the center of the thread at right angles to the axis of the tap. It is evident that all these requirements in regard to threading must be filled in order to make a perfect tap.

In manufacturing, where tools and holders specially made for the purpose are used in threading taps, there is little danger of the inaccurate or unsymmetrical angles of the thread. It is therefore the practice simply to inspect the angle diameter and the lead of the tap. If these two prove correct within the prescribed limits, and if the outside diameter of the tap blank was inspected before threading, there is little danger of any serious inaccuracies in respect to the other details of the thread. It must, however, be understood that the threading tools and the alignment of the threading lathes must be subject to inspection at certain intervals, if the chances of error are to be as much as possible guarded against.

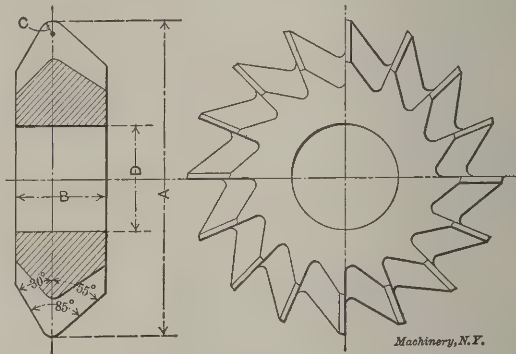
Fluting Hand Taps.

The flutes of a tap serve two purposes. They provide for cutting edges for the threads and form channels for the carrying off of the chips. The form of the flute is greatly important, as it determines the cutting qualities of the tap as well as the ease with which the chips will be able to pass away from the cutting points. The main qualities looked for in a tap are strength and ease of working, provided the tap is otherwise correct. In order to obtain strength, a shallow flute with no sharp corners is the first requirement. An easy-working tap again requires a considerable amount of chip room and consequently a comparatively deep flute. The correct flute, therefore, is a compromise between a flute which will give the greatest amount of chip room and the greatest strength to the tap. Besides this, the fluting cutter must be of such shape as to be easily produced and easily kept in good order, and with a form of teeth as will permit heavy chips to be taken when the taps are fluted.

Fluting Cutters for Hand Taps.

The present practice is to provide hand taps with deep straight-sided flutes having a small round at the bottom produced by a cutter such as is shown in connection with Table I. The included angle between the sides is 85 degrees, 55 degrees on one side and 30 degrees on the other. The thickness of the cutter should be approximately equal to 7-16 D + 5-16 inch, if D equals the diameter of the tap. The radius of the cutter ought to be equal to $\frac{D}{4}$, but should not in any case exceed 7-16 inch. The diameter of the cutter depends, of course, not only upon the diameter of the tap to be threaded, but also on the size of the hole in the cutter for the milling machine arbor. The common practice is to use cutters with ¾-inch hole for the smaller diameters of taps, say up to and including ¾-inch, and 1-inch hole in cutters for large diameter taps. In such a case one can make

TABLE I. DIMENSIONS OF FLUTING CUTTERS FOR HAND TAPS.



Diameter of Tap.	Diameter of Cutter.	Thickness of Cutter.	Radius.	Diameter of Hole in Cutter.
	A	B	C	D
1/4	2	3/8	1/16	3/4
3/8	2 1/4	1/2	3/32	3/4
1/2	2 1/4	1/2	1/8	3/4
5/8	2 1/4	5/8	5/32	3/4
3/4	2 1/4	5/8	3/16	3/4
7/8	2 1/2	3/4	7/32	1
1	2 1/2	3/4	1/4	1
1 1/4	2 1/2	7/8	5/16	1
1 1/2	2 3/4	1	3/8	1
1 3/4	2 3/4	1 1/8	7/16	1
2	3	1 1/8	7/16	1
2 1/4	3	1 1/4	7/16	1
2 1/2	3 1/4	1 3/8	7/16	1
2 3/4	3 1/4	1 1/2	7/16	1
3	3 1/2	1 5/8	7/16	1
3 1/2	3 3/4	1 7/8	7/16	1
4	4	2	7/16	1

$$\text{Diameter of cutter} = \frac{D}{2} + 2 \text{ inches,}$$

in which formula D, as before, equals the diameter of the tap to be threaded.

Table I. is figured from the formulas given. The figures given in the table are, however, practical working figures and are only approximately the values figured from the formulas, whenever these values give dimensions unnecessarily fine and in too small fractions. Of course, the nearest ¼ of an inch is near enough for the dimension in regard to diameter, and the nearest ⅛ inch in regard to thickness. The radius, however, must be given in finer sub-divisions, as 1-32 or even 1-64 inch makes a considerable difference in this respect. The lands of the tap, when threaded with cutters having rounded instead of straight sides, may be somewhat narrower than the lands in taps threaded with the cutters just described, because

* For additional information regarding the making of hand taps see the following articles previously published in MACHINERY: Tool making: Taps, April, 1904; Proportions of Hand Taps in Sets, December, 1905; Acme Taps in Sets, January, 1905; Square Thread Taps in Sets, March, 1905; Relief of Taps, October, 1905; Lathe Gearing Compensation for Changes of Lead due to Hardening, April, 1905; Formulas for Determining the Proportions of Taps, January, 1907 (Engineering Edition only); Table of Dimensions, Data Sheet Supplement, January, 1907.

† Address: 692 Hancock St., Brooklyn, N. Y.

the latter tap requires wide lands in order to make up for the loss of strength due to the straight-sided, deep, sharp-cornered flute. It must be remarked, however, in this connection, that the width of the lands does not depend entirely upon the necessary strength of the tap. As a hand tap, as a rule, receives all its guidance from its lands resting against the walls of the nut to be threaded, it is necessary to have the lands wide enough so that they steady the tap during the tapping operation.

Number of Flutes.

The correct number of flutes can be found approximately from the formula

$$\text{Number of flutes} = \frac{11\,D}{8} + 2\tfrac{3}{4},$$

in which formula D equals the diameter of the tap. If one figures a table from this formula, one will find the number of flutes for various diameters as stated in Table II. It will be noticed that the number of flutes for hand taps in this table are given as 4, 6 and 8, the odd numbers 3, 5 and 7, which would ordinarily also be the results obtained from the formula, not being used. The reason for this is that an even number of flutes enables one to measure the diameter of the tap in all cases with ordinary micrometers. If an odd number is used, the measuring of the diameter is rather complicated, and requires a gage to which to fit the tap. Even then there will still be more or less uncertainty unless the tap is of standard diameter.

TABLE II. NUMBER OF FLUTES IN HAND TAPS.

Diameter of Tap.	Number of Flutes.	Diameter of Tap.	Number of Flutes.	Diameter of Tap.	Number of Flutes.
1/4	4	1	4	2 1/2	6
3/8	4	1 1/4	4	2 3/4	6
1/2	4	1 1/2	4	3	6
5/8	4	1 3/4	6	3 1/2	8
3/4	4	2	6	4	8
7/8	4	2 1/4	6	..	..

In regard to the number of flutes there is some difference of opinion. There are those who consider four flutes the proper number to use on all sizes of taps with the width of the land about one-fourth the diameter of the tap. However, on large taps the land will be rather wide if made according to this rule, and better results will be obtained by increasing the number of flutes in accordance with the formula previously given.

Convex Fluting Cutters.

Sometimes ordinary convex cutters are used for fluting taps. A formula,

$$T = \frac{8\,D}{3\,A},$$

for the thickness of a half-round cutter to be used for fluting taps, was given in MACHINERY, June, 1906. In this formula

T = thickness of the cutter,
D = diameter of the tap,
A = number of the flutes.

If we, for instance, wish to flute a 1-inch tap with four flutes, the thickness of a convex cutter for the purpose would be

$$\frac{8 \times 1}{3 \times 4} = \frac{8}{12} = 0.667,$$ or 11-16 inch, approximately.

Cutting Taps with Dies.

While it is rather common to cut the threads on taps with dies, instead of cutting the thread in a lathe, it is a practice which can hardly be recommended. Any inaccuracy in the lead of the thread of the die will be duplicated in the tap, and still further augmented by the change in lead in the tap due to hardening. Sometimes, when the threads on small taps are cut with dies in screw machines, it is found that the taps have a "stretched" thread, or in other words, that the lead of the thread is longer than the standard lead. On examination the die may be found to be properly made, but further investigation may show that the heavy turret slide of the screw machine was dragged along with the die, and this has caused the thread to stretch, making the lead long. For this reason it is not advisable to cut the thread of taps, which are required to have the highest possible degree of accuracy, in a screw machine. It is particularly bad practice in the case of taps with a long threaded portion or taps used for threading long holes, as the inaccuracies in lead will be so much the more pronounced.

The opinion that taps stretch or become long in the lead when cut by dies in screw machines, is one that is not universally accepted, and it must be admitted that the reason given for this occurrence does not seem entirely plausible. Whatever be the cause, however, the fact that taps cut in screw machines are liable to be inaccurate remains undisputed.

It is true that it is the practice with some firms manufacturing taps to cut the thread with dies in a screw machine, but in the case of manufacturing some factors enter which make this permissible. In the first place, the difference in price when threading in a screw machine or cutting the thread in a lathe is so great that a number of taps can be thrown out at the final inspection, if their inaccuracy in lead is greater than the limits of error permitted, and a saving may still be the result of the method employed. It must be understood, however, that such a procedure is applicable only to small taps, where the loss of material is not very significant, should a tap not pass the inspector, but this process should not be applied to taps where it is wanted to insure great accuracy. In such cases nothing can compare with a thread cut in a lathe, provided with a lead screw which itself has been properly tested as to its own accuracy. For ordinary machine screw taps, however, in manufacturing, the screw machine may answer the purpose and prove economical.

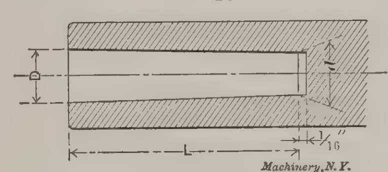
* * *

TABLE OF JARNO TAPERS.

In the How and Why section of our April issue we had occasion to refer to the Jarno standard taper, and we gave there the standard formulas for this taper. Mr. Arthur B. Babbitt, of Hartford, Conn., has sent us a table of Jarno tapers giving the large and small end and the length of the taper. These dimensions, as we previously remarked, are easily found from the formulas, but some of our readers may appreciate having a table figured out.

Taper per foot = 0.600 inch.
Taper per inch = 0.050 inch.
No. of taper = N.

$$D = \frac{N}{8} \qquad d = \frac{N}{10} \qquad L = \frac{N}{2}$$



No. of Taper.	D	d	L
2	.250	.20	1
3	.375	.30	1½
4	.500	.40	2
5	.625	.50	2½
6	.750	.60	3
7	.875	.70	3½
8	1.000	.80	4
9	1.125	.90	4½
10	1.250	1.00	5
11	1.375	1.10	5½
12	1.500	1.20	6
13	1.625	1.30	6½
14	1.750	1.40	7
15	1.875	1.50	7½
16	2.000	1.60	8
17	2.125	1.70	8½
18	2.250	1.80	9
19	2.375	1.90	9½
20	2.500	2.00	10

* * *

When doing some job work on electric wiring, do not run flexible wires over boxes, partitions or into closets. Have permanent wiring installed. Flexible wires used in this way may prove dangerous.

PUMPING SAND.

JOHN BRADFORD.*

The hydraulic dredge during the past decade has been used quite extensively, and the usefulness of the pump in connection with dredging fully demonstrated and firmly established. The dredging of sand, gravel, mud, or marl can be done with a centrifugal pump at much less cost than is possible with the old style dipper, or scoop dredge. There are various reasons why the pump is more economical: First, the initial cost of the plant is very much less, and likewise the cost of maintenance, as there are less repairs to be made and not so many men needed in its operation. In addition to this, where there is sand, gravel, or other material that will readily pass through a pump, it can be raised more rapidly than is possible with the dipper, or scoop dredge.

The centrifugal pump is universally used for dredging, and is by far the best type for this purpose, although we shall consider later a sand pumping problem where it would prove inadequate. A dredge pump differs somewhat from the standard type. The pistons or fans are generally fitted with water bearings to prevent the sand from cutting the journals, and are so designed that sand or gravel passing through them does not materially increase the clearance between the fan and pump casing, which would, of course; impair the pump's efficiency. Most dredge pumps have two suction pipes, thus extending the range of operation. The ends of these pipes are fitted with what is known as a "sand agitator," a device for loosening the material so it can be easily drawn into the pump. Some pipes simply have spiked ends which drag along through the sand, while at least one large dredge is equipped with steel spiked wheels which are actuated by a special engine. Then there is the "water jet" type, acting under a pressure of from 60 to 100 pounds furnished by a special duplex pump. The dredge "Iota," one recently built for work on the Mississippi river, is fitted with this latter type. This particular dredge has been doing excellent work, and has exceeded the expectation of its designers. The pump is of large centrifugal type, having a 32-inch discharge, and is capable of delivering at least 1,000 cubic yards of sand per hour through 1,000 feet of pipe. The discharge pipe is made of one-quarter inch steel plate, and the fifty sections coupled with swivel joints, are supported upon pontoons. Of course, there is much greater economy where the material can be raised and discharged through pipes to the shore in one operation, which generally can be done in river and harbor work.

The proportion of sand to water that can be pumped, depends on its fineness and specific gravity. In a well-equipped plant working under favorable conditions, the proportion of sand is about fifty per cent. The calcareous, and argillaceous sands flow more freely than the siliceous, and there is less liability of them clogging the discharge pipe. The pumps usefulness in connection with this work is not confined alone to dredging. Where large quantities of sand are to be transported from one point to another, the pump has in some instances taken the place of the horse with most economical results. The writer having inspected one such plant, will give a few details concerning its operation.

The sand, which is siliceous and used for making glass, is taken from the mine in a lumpy condition, which necessitates first the use of a crusher for its disintegration. It is then fed into a revolving sieve, and after the sifting process, it is carried by a conveyor through a series of troughs filled with running water. After being washed and made marketable, it is ready to be pumped to the point of shipment almost a mile distant. The centrifugal pump so well adapted to this class of work could not well be used here, owing to the great length of the discharge line. The work is accomplished, however, with fairly good results by a 14 x 6 x 12 inch direct-acting outside packed plunger pump. The discharge pipe is four inches in diameter, and its maximum height above the pump is forty feet. There are few curves in it, and none of them under 125 feet radius. The sand and water must be forced through this with considerable velocity, to prevent the sand from precipitating in, and clogging the line. Of course the wear on the pump is excessive. The plungers, which are cast steel, last about six months, and are packed with flax-packing which has given the best results. The valves are the "flap" type, and of rubber, the quality determining the length of time they can be used, the best being unfit for use after one month's service. It is obvious that this pump should be kept in good repair, as a sudden stop would mean clogging the entire discharge line with sand.

When it is desired to stop the pump, the sand is shut off, and clear water pumped until the discharge line is entirely clear. One hundred and fifty tons of this sand are pumped during the ten hours run, from the mine to the "dry house," where, after the drying process, it is ready for shipment.

* Address: 219 Cumberland St., Brooklyn, N. Y.

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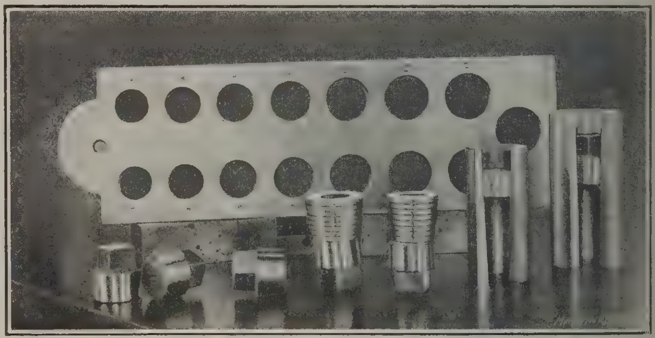
GAGES FOR MAKING MUD AND WASHOUT PLUGS.

M. H. W.

In traveling around among various shops I find in many instances no particular care being taken to insure well-made and uniform mud and washout plugs. Of course, many shops have excellent methods to produce first class plugs, and I am not addressing these remarks to such shops but only to those who have as yet not made special devices for this class of work, and who by force of circumstances are making these plugs in a common lathe, possibly depending upon a first year apprentice to do this most important job. The accompanying cut shows a plate tapped out to suit the various sizes of plugs likely to be required. The holes in the plate are numbered,



Gages for Making Mud and Washout Plugs.

the tap has lines marked as far as it enters the hole on the outside, and likewise numbered. The mud plugs are also numbered, when they have been threaded. The small step gages shown are turned to the exact size of each plug, numbered and hardened, and are made to fit over the tail-stock spindle of the lathe. Thus in turning the plugs, it is only necessary, in finishing, to bring the tool point up to the step corresponding to the size required, which does away with much needless calipering. The taper test gages shown are bored the desired taper, and afterwards slotted. The use of these makes it a very easy matter for a foreman or inspector to check up from time to time the accuracy of the work turned out. These gages, it is understood, are not threaded.

* * *

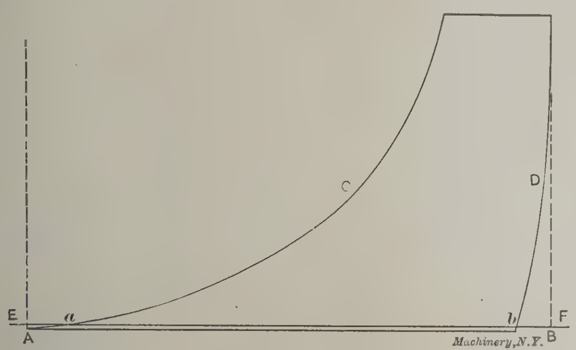
A correspondent in the course of a recent contribution referred to the assertion of an engineer that the crank-pin of a large Corliss engine ran so well with a certain kind of bearing that it was actually *cooler* than the surrounding atmosphere. This was attributed by the engineer to the cooling effect due to its rapid motion through the warm air of the engine room. This queer idea, of course, is not supported by the fact. A warm breeze blowing on one's body does give the sensation of coolness but it is so simply because of the increased evaporation from the skin. In the case of a dry piece of metal such effect is entirely absent, and it can by no possibility have a lower temperature than the surrounding air. The only reason that an electric fan is of any value on a hot day is simply that of circulating the air and increasing the evaporation of the body, thereby reducing its temperature. An electric fan in a refrigerator would be as good as nothing at all; in fact it would tend to raise the temperature as the friction of the flowing air would create heat.

STANDARDS OF EFFICIENCY IN COMPRESSED AIR PRACTICE--THE AIR COMPRESSOR AS AN AIR METER.

FRANK RICHARDS.*

Nothing, perhaps, is more common in engineering practice than to state results as percentages of efficiency. Nothing is also perhaps more common than a certain vagueness and uncertainty of standard, with processes of deduction which are often incorrect or unreliable. We accept stated percentages of efficiency without sufficient scrutiny, and as a consequence some things in mechanical or engineering lines obtain credit and apparent practical endorsement which are not their due.

A few years ago there was being exploited a certain device —not pneumatic—for raising water, the principle employed being ultimately that of the hydraulic ram, operating not directly, but through a series of mechanism. Given a body of water at a certain level *A* from which it is to be raised to another level *B* the vertical lift would of course be the height *A B*, and if a steam pump had been employed it would have



Air Compressor Diagram.

been credited with that lift. In this case, however, the conditions of operation required that a certain weight of water should fall from the level *A* to a lower level *C*, the foot-pounds of this fall being taken as the power expended, which was all right. The water raised, however, was credited with being raised from this lower level *C*, or through the height *C B* instead of the height *A B*, which gave the device probably one-third greater efficiency than it earned, and although it has not come into permanent use, its handsome record thus computed is to be found embalmed in some mechanical textbooks and works of reference.

We have before us an interesting example in the computation and assignment of efficiencies in the case of a certain device for raising or pumping water by the use of compressed air, where the percentage of efficiency of the apparatus is put forth in the usual way, and all are expected to accept it as absolutely correct and unquestionable. There is no suggestion here that the computer of the percentage was not perfectly honest or that there was any intention to bias the results in either direction, but still the results, or rather the assumptions upon which they are based, invite some criticism.

The unit assumed was the power used to compress the air as shown by the indicator card of the air compressing cylinder; then the foot-pounds of the water lifted made the percentage of this. Now, this cannot possibly be correct practice, because the efficiency of the compressor is here mixed with that of the pump, and the efficiency of the latter could be made to vary widely according to the style of the compressor employed. If one wanted in this case to show as high a percentage as possible for his air-operated device he would employ the best compressor and the best conditions of compression possible. If the air pressure employed was high enough to make two-stage compression the more economical, then the power shown by the sum of the indicator cards of the two air cylinders would be less than the power shown for the same work by the card from the single cylinder of the single-stage compression, and the former would give the pump a higher efficiency than the latter, although its actual work was identical in the two cases.

Comparative efficiencies in two or more cases of pumping under different conditions might, of course, be computed from the power record of the air cylinder of any compressor, provided the entire output of compressed air was used by the pump in each of these cases, but nothing could be accurately deduced from it as to the *absolute* efficiency in either case.

Indicator Card Best Basis for Computing Efficiency.

The indicator card of the air compressing cylinder does, after all, provide the best basis from which to compute the efficiency of air operated devices, but not by its power record. There seems to be nothing by which compressed air efficiencies can be reliably measured but the actual consumption of air, and the air compressor is the best air meter known. To use the air compressor as an air meter its computed piston displacement per stroke, allowance being made for piston rod and also for piston inlet pipe if used, requires to be corrected by the evidence of the indicator card, and nothing else will do it.

The air cylinder at the beginning of the compression stroke is not normally full of air in advance of the piston at full atmospheric pressure, but somewhat lower. Usually the piston must advance an appreciable and easily measurable distance, and must have begun its actual work of compression before the compression line *C* rises to and coincides in vertical position with the atmosphere line as at *a*, and only when these lines do coincide can we say that the cylinder in front of the piston is filled with air at precisely atmospheric pressure, or free air. Then at the other end of the stroke all of the air compressed is not expelled from the cylinder on account of clearance spaces which the piston at the end of its compression stroke cannot entirely occupy, and thereby displace and expel all the air, so that upon the return stroke of the piston this air first of all re-expands down to atmospheric pressure, the atmosphere line *E F* not being reached by the re-expansion line *D* until the piston has traveled a portion of its return stroke. The free air, or the air at atmospheric pressure, actually compressed and delivered is the contents of that portion of the cylinder represented by the distance between the point *a* where at one end the compression line rises to and crosses the atmosphere line and the point *b* near the other end of the stroke where the re-expansion line drops to and touches the atmosphere line again, this distance being compared with the total length *A B* of the indicator card in computing the capacity percentage, the latter of course representing the total piston displacement per stroke. What the percentage may be, or the difference between the theoretical and the actual delivery, can only be precisely determined, in this case, by the evidence of the indicator card, and each compression cylinder has its own individual equation. The figure here used for illustration shows the atmosphere line and the intake line as entirely separated, which is not often found in practice.

Influence of Temperature.

When we have thus ascertained the actual volume of air delivered per stroke at atmospheric pressure, and its percentage of the entire capacity of the compressing cylinder, there still remains a question as to the temperature of the air, this also affecting the ultimate result. If the temperature of the air filling the cylinder is higher than normal, then its volume also will be proportionately greater, and the air when cooled to the normal temperature will be reduced in actual volume, and by this the percentage of compressor capacity will also be still further reduced.

As to the actual temperature of the air filling the cylinder at the beginning of any compression stroke it would seem that there must always be more or less uncertainty, as there is no means known for ascertaining and proving the temperature within the cylinder at any precise moment. One thing, not generally recognized, is that with the compressor running at full speed the temperature of the air in the cylinder at the end of the re-expansion and the beginning of the intake is not high, that in fact the temperature is presumably somewhat lower than that of the incoming air.

It is well understood that the temperature of air always rises during compression and *simultaneously with the compression*, so that the temperature at any instant during any act of compression is always that due to the compression in

* Address: 229 W. 135th St., New York, N. Y.

addition to the initial temperature. If any heat is given off from the air during or upon the completion of the compression, as for instance to the body of the cylinder, to the cylinder head or to the body of the piston, then the temperature of the compressed air will be somewhat lower than precisely that due to the compression. We know that the air during its compression and after compression, but before its expulsion from the compressing cylinder, does give off some of its heat, because the cylinder and the piston are heated by this action, thus giving occasion for the employment of the water jacket or other cooling devices.

As the temperature of the air rises during compression, so it correspondingly falls during expansion, simultaneously with the expansion and in inverse ratio, precisely corresponding to its rise during compression. If a body of air at any initial temperature is compressed by the contraction of the space in which it is confined from any initial pressure to any higher pressure, then upon the restoration of the space to its original dimensions and the fall of the pressure of the air to the initial pressure, the temperature of the air becomes precisely what it was at the beginning of the compression; and if the temperature of the air at the beginning of this re-expansion is at all lower than that actually due to the compression, then the temperature upon the termination of this re-expansion back to initial pressure must also be lower than at the beginning of the compression. It is quite demonstrable, therefore, that in the actual, practical operation of an air compressor the air at the end of the compression stroke is not quite as hot as it would be if its giving off of heat were entirely prevented, and its re-expansion down to initial pressure therefore leaves its temperature somewhat lower than that at which it entered the cylinder before its compression had begun.

Up to the precise moment when re-expansion in the cylinder begins the air is being cooled somewhat by giving off some of its heat to the cylinder and piston, then after re-expansion begins we must admit that this process is reversed, but the time elapsing before the re-expansion is completed is so short that this re-heating has little effect, and it seems quite certain that the air in the cylinder—this re-expanded air filling the cylinder space at the beginning of the intake stroke—is cool air, certainly cooler than at the beginning of its compression.

As to the temperature of the new charge of free air which enters the cylinder for the succeeding compression stroke we must acknowledge that its temperature is never lowered in any compressor known and is generally raised by its contact with the more or less heated metal surfaces as it enters to fill the cylinder. The different ways in which the air enters the cylinder, or the style, number and arrangement of the inlet valves, and the directness or the sinuosity of the admission passages make different rates of opportunity for the air to absorb heat as it passes in. It may be said in a general way that the more the air is subdivided and the more numerous, intricate and minute the passages by which it enters the cylinder, the more chance it has to be heated.

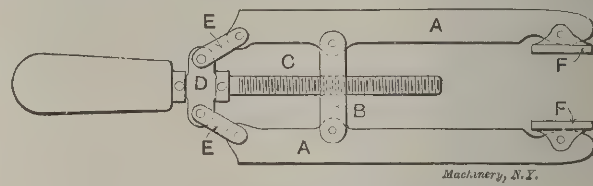
Effect of Inlet Valves.

The inlet valve arrangements of different compressors are almost as numerous as their builders, and there would be little profit in discussing them. There is, however, one inlet valve arrangement which seems to have the right to claim special mention in that it is unique and absolutely alone among all the devices employed, and this is the piston inlet valve. By the use of this valve the intake air passes through the piston inlet pipe, which is not hot, in a solid column and at a speed approximating and often exceeding a mile a minute. Its mass remains equally unbroken in the body of the piston, and then its passage of the lips of the single valve and valve seat is, for any portion of it, instantaneous. The rise of temperature which occurs to the air in its passage into the cylinder by this route would seem to be quite minute, and this rise of temperature seems to be the only thing to be allowed for in accepting the air compressor, upon the evidence of its indicator card, as a reliable air meter. It therefore would seem to be absolutely reliable for record of air compressed and actually delivered, to within, say, five per cent, which is as near as the average gas or water meter works.

ITEMS OF MECHANICAL INTEREST.

IMPROVED PATTERN-MAKER'S CLAMP.

An interesting clamp for pattern-makers and others is shown in the *Zeitschrift für Werkzeugmaschinen und Werkzeuge.* As seen from the cut, the device consists of two levers *A*, turning around pivots in the intermediate part or brace *B*, which latter is threaded to receive the clamp screw *C*. On this

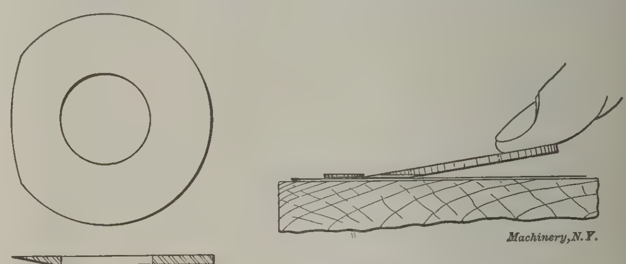


Improved Pattern-maker's Clamp.

clamp screw is mounted a bushing *D*, provided with projections to which are connected the links *E*. These links in turn are connected with the levers *A*. The lower part of the levers carry swiveling jaws *F*. The action of the clamp is readily perceived from the cut; the clamping pressure is evidently very great on thin work, due to the toggle action of links *E E*. In the position shown, however, it is not so effective.

A CONVENIENT TACK-PULLER.

The cut shows a simple and effective tool noticed in a drafting room recently, used for drawing thumb or other tacks. It is made by holding a half-inch washer to the face of a revolving grindstone or emery wheel until the operator is satisfied with the shape produced. The edge is sharpened so it can be pushed under the head of the tack, when the thumb

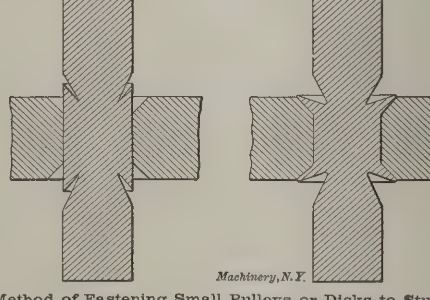


Convenient Tack-puller.

of the operator, pressing on the upper edge as shown, withdraws the tack. This little instrument is well enough known, but perhaps there may be some draftsmen who have never happened to see it. Its special advantages are the ease with which the stock it is made from can be obtained and the convenient hole with which it is provided, which allows it to be attached to a string and suspended from the drawing table.

METHOD OF FASTENING SMALL PULLEYS OR DISKS TO STUDS.

The Siemens-Schuckert Works in Berlin, Germany, has patented a method of connecting small disks to the studs carrying them. The method is specially intended for electrical connections and adapts itself well for copper studs. The cut



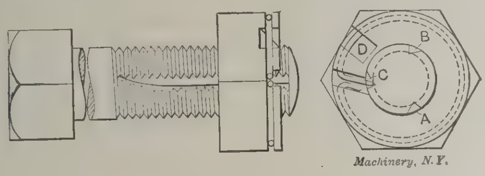
Method of Fastening Small Pulleys or Disks to Studs.

herewith, which is taken from *Zeitschrift für Werkzeugmaschinen und Werkzeuge*, plainly shows the method of fastening. The stud is inserted in the disk, the hole of which latter is chamfered on both sides. An angular cut is taken in the stud on each side of the disk with a pointed tool, as shown, and the lip portion formed by the cut is bent outward into the chamfered portion of the hole of the disk, thus keying

the disk to the stud as well as preventing end play. For purposes where an electric connection is wanted rather than a joint taking a heavy thrust, this method has proven very satisfactory.

POSITIVE LOCK NUT.

The accompanying illustration (taken from the *Horseless Age*, February 20, 1907) shows a lock nut and bolt invented by a Chicago man. The bolt has three grooves, *A*, *B* and *C*, which act as ratchet teeth. The upper part of the nut is so formed that a spring ring encircles it, the end of the ring being turned inward, as shown at *C*, thus coming in contact

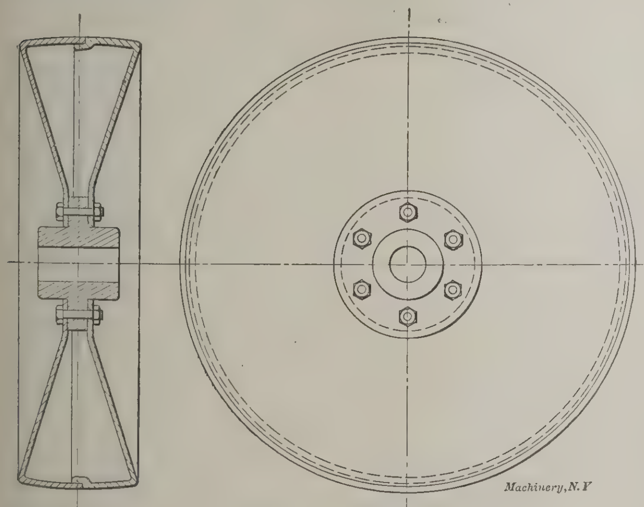


Positive Lock Nut.

with the side of the groove and effectually preventing the nut from being turned in a left-hand direction. However, right-handed rotation is possible, as the grooves are so shaped that the end of the spring ring slides up the inclined surface easily. In order to release the nut, a slot, *D*, is provided, which allows the point of a nail or any similar object to be placed under the spring ring and thus raise the point out of the groove, when the nut can be taken off. This arrangement allows an adjustment at any time of one-third of a rotation.

STAMPED STEEL PULLEYS.

A new form of pulley, introduced by Messrs. Walker & Holroyd, Laisterdyke, Bradford, England, is described and illustrated in the *Mechanical World*, April 5, 1907. A line cut showing the design of these pulleys is given below. The pulleys are made up of two drawn steel stampings, each of which is concave in form. One half has a portion bent down along its periphery, and the other half fits into the groove produced. The hub is of cast iron and is secured to the pul-

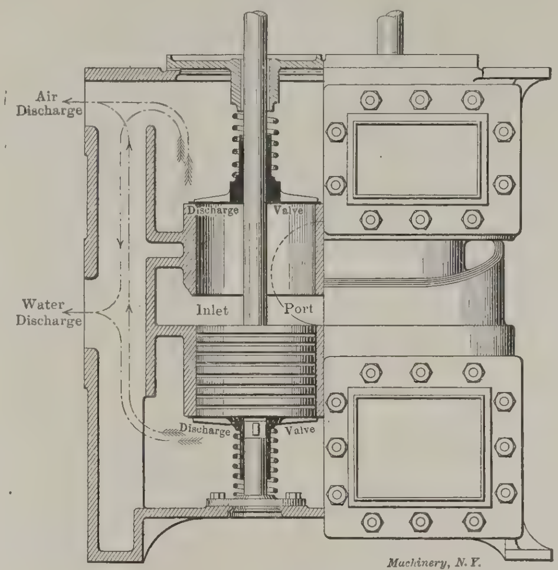


Stamped Steel Pulley.

ley body by rivets or screws. These pulleys, according to the claims of the makers, are 30 to 40 per cent lighter than ordinary cast iron pulleys, and being uniform in their construction and evenly balanced, they are suitable for running at very high speeds. Being without spokes, there is no fanning of the air and accordingly no loss of power due to atmospheric resistance. The absence of sharp edges and the fully enclosed shape also obviate the danger of accidents, and there is less injury to the belt when put on or thrown off.

IMPROVED AIR-PUMP DESIGN.

The steam turbine can approach the best reciprocating engines in point of economy only when exhausting into a high vacuum, and this fact is doubtless responsible for considerable improvement in condensers and air-pumps. The accompanying illustration shows the Fraser double-acting air-pump, which was designed to reduce clearance space to practically zero. This type of air-pump, built by Douglas Fraser & Sons, Arbroath, Scotland, is so constructed that the condensing water flows directly into the barrel of the pump without passing through inlet valves or contracted ports. The water is forced out through discharge valves covering the ends of the two cylinder sections, and the piston touches each valve alternately so that the clearance spaces are emptied com-

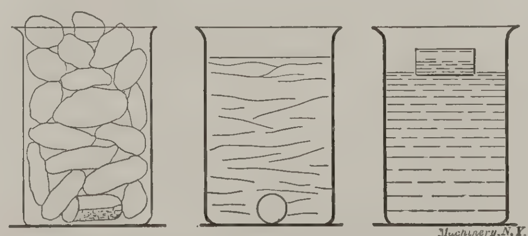


Improved Air-pump Design.

pletely each stroke, consequently there is little or no expansion of vapor behind the piston on the return stroke and every stroke of the pump displaces very nearly, if not quite, the exact cubic contents of each cylinder section.

FLOW OF PLASTIC SUBSTANCES.

It is claimed that a mushroom will grow up through the asphalt of a city street, and that such cases have been noticed. It is almost inconceivable at first thought that such a tender plant as a mushroom could break its way through the tough, sticky asphalt which requires the sturdiest blows of a laborer's pickax to dislodge. The phenomenon, however, like many other strange actions of natural forces, is capable of simple explanation. A German publication recently illustrated the action of the mushroom growing through tough asphalt by an experiment made with lumps of cobbler's wax and a cork, and the accompanying cut shows the stages of the experiment. In the first view a glass jar is shown containing a cork at the bottom, upon which are piled lumps of cobbler's wax until the jar is filled. After a period the lumps of wax will settle down and become one solid mass, as illustrated in the second view, the cork still remaining at or near the bottom. But, a still further period of time will show the cork slowly lifting



Example of the Result of Persistent Action of Small Force.

through the sticky tenacious mass, owing to the power of displacement, the cork being much lighter than the wax. This slow but sure action is analogous to that of the mighty mountain glacier which will yield to the gentlest force operating continually and in time it will be observed to follow the direction of a very slight pressure. It may take months or years to produce an appreciable effect, but the effect will surely follow. In the case of the mushroom growing through the asphalt, the pressure exerted by the growth of the fungus is extremely slight, but it is persistent and will surely displace the asphalt in time, weather conditions being favorable.

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RAILWAY MACHINERY

A SPECIAL EDITION OF MACHINERY FOR THE RAILWAY SHOP, DEVOTED TO LOCOMOTIVE AND CAR EQUIPMENT AND MECHANICS.

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We solicit communications from practical men on subjects pertaining to railway machine shop practice, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

JUNE, 1907.

HIGH-SPEED ELECTRIC TRAINS.

The daily press recently published an enthusiastic account of tests made on the New York, New Haven & Hartford R. R., with the new electric train service, which were alleged to have demonstrated that electric trains can be run at the rate of 100 miles per hour. This installation, it will be remembered, is of the overhead trolley wire type with motors of the single-phase form. The inference of some of the published articles was that the superiority of the system would make it possible for the transportation company to handle their trains at a very high rate of speed, commercially. Of course, the fact that trains were run at high speed with alternating-current does not necessarily show superiority in this respect over the direct-current system. It is possible to run electric trains on the direct-current system at 100 miles per hour, or even higher speeds if it was commercially desirable, but it is quite improbable in the span of our generation that speeds of 100 miles per hour will become commercially profitable with either system—direct-current or alternating current—save it may be between cities where the density of traffic is very great, as for instance, between New York and Philadelphia. The limitations of braking and the cost of power seem to indicate that such high speeds will be out of the question for any service where stops are frequent.

* * *

BRITISH SENTIMENT FOR OLD LOCOMOTIVES.

In his presidential address before the British Institution of Mechanical Engineers, Mr. T. Hurry Riches traced the history and development of the locomotives, cars and operating methods of the British railways. It is interesting to note that some of the improvements in British practice have had their origin here—among them the locomotive cab, the air brake and the Pullman car. Conditions in England, however, are different from those in our country, so there is good reason for the marked difference that still exists between American and British practice. One of the handicaps met with over there is the limitation as to height and width imposed by the standards to which the various tunnels and bridges have been built. This makes the large, high-hung boiler with which we are familiar, an impossibility, and puts a limit to the maximum power obtainable.

One remark in this interesting paper particularly attracted our notice. "A word of regret I must express, that the fine old single-driving-wheeled locomotive has to be superseded. These engines . . . did admirable work so long as the trains they were required to haul did not exceed their tractive capacity, but the day seems to have arrived when sufficient adhesion cannot be obtained on one pair of wheels." It is difficult to say at first reading whether this expression of regret was a sentimental one, or was called out by real advantages which the discarded type of locomotive may have possessed over its coupled competitors. There is reason for a regret of this kind in the passenger service at least, where high tractive power is not required except in starting; and where boiler capacity is the prime consideration.

It is noticeable, however, that European engineers in general and British engineers in particular, have a strong affection for the machines and structures which they have been designing and building for years past; and it sometimes seems as though it required a strong effort to get them to break away from old practices even when new ones are much better. The lack of this tendency among American designers does not imply, however, a lack of idealism and real affection for their profession. On this side of the ocean the engineer's ideals are directed toward the accomplishing of desired results, and on these his attention is firmly fixed. The machines and structures by which he tries more or less perfectly to attain these results are but means to an end, and are discarded without mercy or regret when something better can take their place.

* * *

STEEL RAIL DANGERS.

The report made to the State Railroad Commission of New York State shows that for the first three months of the present year there were 3,014 broken rails reported on the railroads of the State. No one needs to be told that the great increase of rail breakages is responsible for many of the serious accidents that have made our railways notoriously conspicuous during the past year. The fact that steel rails show a greatly increased percentage of breakages may be attributed in part to the increase of traffic and the heavier locomotives and cars that are carried, but the increase of breakages is totally disproportionate. It is doubtful if our heavy section rails are really as safe as the lighter sections rolled ten years ago. The first cause undoubtedly is inferior product in point of manufacture, but the retention of the Bessemer process, which is greatly inferior to the open-hearth process for heavy sections, is considered to be fully as censurable. The experts who know what steel should be, complain bitterly that the steel rails furnished by our large steel-making corporation is far below the quality that should be expected, even making all allowance for the present process. The paper read recently before the New York Railroad Club by Mr. Robert Job on steel rail defects, showing the effects of piping, segregation, improper cropping of ingots, etc., was an eye-opener to many railway men. This carelessness of manufacture—or dishonesty—is simply due to the pressure of the demand and the desire to make an enormous profit. The reluctance of our principal steel-making corporation to abandon the Bessemer steel process and to enter into the manufacture of steel rails by the open-hearth process is partly because of the great cost of making the change, but conservatism plays an important part, notwithstanding our reputed liberality of thought and quickness to seize new ideas. The open-hearth process is bound to come, for it produces rails that are better suited to railway requirements than those made by the Bessemer process. While the Bessemer process made the steel rail possible, it nevertheless has certain vital defects that operate against the integrity of rails and structural material rolled from it, and much care is required to produce sound materials. The fact that the open-hearth process is better suited to all requirements, whether railroading or structural, will relegate the older process to the limbo of discarded things, and no industry is more vitally interested in speeding the day than that of railroading.

* * *

An epoch-making (?) invention has been made by a Mr. Louis Brennen, of London, it being a mono-rail car which defies gravity and offers but a mere fraction of the rolling resistance of the ordinary car running on two tracks. The secret of this wonderful invention is a gyroscopic device which maintains the equilibrium of the vehicle no matter whether the car is evenly loaded or whether the load is all on one side, the inventor having gotten his idea from observing the spinning top. While the device *might* maintain a car in a level position so long as the gyroscopic wheels are in operation, we very much doubt that it will create anything more than a mild interest on the part of railroad men.

OUR FOREIGN MACHINERY TRADE.

Although our foreign trade in machine tools has probably never been so large as during the twelve months past, those who are familiar with conditions in Europe believe it has reached the limit, and that with the exception of a few specialties which European manufacturers cannot make as cheaply or as well, the sales of our tools abroad are likely to decline unless a change occurs in conditions here. The problem before our manufacturers is a difficult one, because the solution is affected by so many conditions over which they have no control.

The productive ability of American mechanics is so much greater than their foreign competitors that they can largely overcome the adverse percentage of labor cost; but as the foreigners learn our methods, which they are rapidly doing, this percentage decreases, and we must reduce the difference between the foreign manufacturer's price and ours, or we shall lose the advantage in his market which our methods have up to this time secured for us. The foreign manufacturer has other things in his favor besides cheap labor—he has proximity to his market, familiarity with local requirements, a national sentiment in favor of home products with all which that implies, and in Germany the active assistance of his government.

Familiarity with these conditions caused us to write our manufacturers of machine tools and small tools, who are interested in foreign trade, for advice and suggestions that would help the situation; and from several hundred replies, representing practically every firm in our field, we have received permission to quote from a score, although the letters were not written for publication. These are arranged without regard to the size or location of the firms, and make interesting reading.

1. "It no doubt is a fact that for the last three or four years, during the period of unusual prosperity in this country, foreign manufacturers of tools have been encouraged to take up the copying of American-made machinery and tools, through the fact that American makers have not been able to take care of the demand made upon them.

"This, of course, is a most unsatisfactory condition of affairs, for there is little encouragement to the American makers to reduce prices to compete against the foreign-made machines, and not until quite recently was it necessary for us to do so; but during the last year there has been such progress made by foreigners in the manufacture of goods by American-made machines furnished for that purpose, that they are now approaching nearer to perfection, and then, of course, with the difference in the cost of labor and material in the foreign countries, they are in a position to compete.

"The subject, as stated in your letter, covers the condition of affairs at the present time, and the question the writer has asked himself a great many times is, What are we going to do about it? I must acknowledge that I have not been able to answer this question with any degree of satisfaction to myself. Pushed as all American manufacturers are to-day to complete orders that come to them without solicitation, almost, it is rather difficult for them to look even to the present, and to formulate a plan for the future is quite out of their minds at the present time.

"I presume when the time comes that American manufacturers require foreign business to keep their plants employed, the conditions will right themselves, and to do this a general reduction in the price of raw material as well as labor would be necessary, all of which at the present time is out of all proportion to the ordinary condition of trade."

2. "Our foreign customers get as good delivery on their orders as our domestic customers do on the same kind of styles and sizes. We thoroughly believe that principle to be fundamental, that one must give them the same service, and while our deliveries have been slow of late, the slowness applies to all shipments equally.

"We have no suggestions to offer in regard to any method by which the foreigners can be prevented from copying our machines or underselling us if they see fit to copy our designs, further than to get in such shape, if possible, to make the very promptest delivery on orders they send us, as we believe this counts for a great deal in the placing and retaining of business."

3. "Ever since we started to do an active European business, about twelve years ago, we have been convinced that it was only a question of time when the European manufacturers of standard tools would develop to the point where they could take exclusive care of their home requirements. In fact, the demand for our line has lasted longer than we originally anticipated.

"We consider it perfectly natural, and in accordance with the laws of political economy, that the Europeans should want to eventually become independent of us; and we believe that in spite of anything that we can do the European demand will steadily decline.

"Broadly speaking, we can see only two ways in which we can stave off the evil day. One is to develop our system of manufacture to such an extent that we can afford to meet European competition on basis of price. The other is to continue to improve our tools to such an extent that the foreigner will be tempted to pay an extra price in order to secure the latest original, rather than a home-made copy.

"We have realized all along the desirability of preserving a foreign outlet for our product, and therefore have continued to make special efforts to extend to our European agents and customers every possible consideration; thus doing our share toward fostering that feeling of confidence without which any systematic effort will fail."

4. "Notwithstanding the condition which you report as existing abroad, we do not see that anything practicable can be done to offset it so long as present conditions exist here. It is simply another instance of the bird in the hand instead of in the bush, and we doubt if any one will be prevailed upon to relinquish home effort while these conditions do exist."

5. "While American manufacturers have more than they can do at the present time, it will pay them well to look ahead and not now neglect the foreign field. We believe that every American manufacturer who desires to increase his volume of business should pay special and particular attention to the possibilities in all foreign markets.

"The most effective way, we believe, to keep thoroughly posted and in close touch with requirements is through what is often termed 'missionary work.' While it is expensive and does not always yield an immediate return, we believe that it surely pays eventually. For our business we already have two representatives in Europe who are not necessarily salesmen, but who go about separately and also with the selling representatives of our agents there, so as to become thoroughly acquainted with requirements and assist the consumers of our goods in the proper use of them in any way that they can. They also promote new trade and arrange for demonstrations of our goods in works where they are not as yet introduced, and in this way lay the foundations for substantial returns later on.

"While we knew that our agents did not promote new trade as much as they might, and that we were not taking advantage of all the possibilities, we are astonished at what we find out from the reports our missionaries are making. If all the manufacturers who are interested to a greater or less extent in foreign trade would wake up to the necessity of giving as careful attention to the foreign market as they do to the home trade, they would find it would turn out to be a great thing for them and the country at large. While missionary work managed from here is quite effective, not as much can be accomplished by it as there would be by establishing a manufactory and a selling force for pushing the goods over there in the same manner as we do at home. That there are great opportunities abroad is beyond question, and if American manufacturers want their share of that business we believe they can secure it.

"Great things could be accomplished by systematic effort, consideration and discussion of the subject. The difficulty will be in securing the interest of American manufacturers for this work, when they are so very busy at home. If they are looking ahead, however, they ought to be willing to spend a little time now on what will benefit them later on."

6. "We think the only proper method to handle foreign trade is for a member of the concern to take a trip at least once a year, getting in touch with his foreign representatives as well as with manufacturers. We feel that has been neglected by nearly all of the American manufacturers in the machine tool line during the past year or two. In fact, we believe that never at any time have they been aggressive enough regarding the foreign trade, and any move in this direction we think would be a good one, especially looking toward a future outlet for our goods when times are a little dull in this country."

7. "The writer went abroad last October and devoted his time to the study of trade conditions in England, Germany, Belgium and France, and to some extent in Italy and Spain, and was indeed surprised to discover the almost bitter feeling existing there against American manufacturers, all brought about through the neglect, or, in fact, indifference, of American manufacturers in general to the foreign market. One foreign manufacturer who has been equipping his plant with modern machinery, mostly American, showed the writer letters from certain American houses (manufacturers), in which shipments of some twenty-five or thirty machines of different makes had been promised nearly nine months before that date and had not then been shipped; and judging from the tone of the American letters, and frequent promises made of shipment, it was quite apparent that the American machinery people in question had simply neglected those foreign orders by using the machines to fill orders here at home at possibly slightly higher prices, and had not only done so once, but had kept

on doing so; and if they thought they were fooling the foreign firm by their promises they were sadly mistaken. This was only one example of the conditions which the writer found to exist in many cases which came to his notice, and in talking of this condition with an American manufacturer, after the writer's return home, he (the American manufacturer) remarked: 'Why should we ship our machines over there when we can get more money for them here?' This seems to be the thought existing in the minds of many American manufacturers at present, and has existed there for the past three years, for they see only the dollar in hand, but lose sight of the fact that a few dollars from the other side might be quite cheering to them a year or two hence.

"The writer does not feel qualified to advise as to a plan to overcome the injury already done to the American machine and tool trade in foreign countries, but thinks the best thing that could possibly be done would be to strongly urge all American manufacturers to go abroad with a view of making a study of trade conditions, for no manufacturer who is alive could go through Europe and talk with manufacturers and dealers there, also visit the principal works, without appreciating the true condition of affairs and what it must shortly lead to, in fact has already led to.

"We have always paid strict attention to foreign trade, and will give a foreign order preference any time, and have been able to work up, and not only hold, but greatly increase, our foreign trade in this way; and while it may not be necessary to give foreign orders preference over home orders in all cases, yet it is well to accord foreign orders at least equal attention.

"The writer's observations abroad disclosed to him that there are a few, too few in fact, American manufacturers who have the correct ideas regarding the way in which foreign trade can be had, and these few concerns are not only doing a very fine business abroad, but they have the respect and confidence of both dealers and manufacturers. These firms have their own representatives over there, men who are thoroughly conversant with the machinery built by the firm they represent, in fact, American mechanics who have worked at the trade in their respective shops here at home, and have been sent to Europe in the interest of their firms to work in connection with the dealers there who represent the American firms. The foreign dealer has good salesmen, but it is quite impossible for him to employ salesmen who are at the same time so thoroughly conversant with all kinds and conditions of American machinery as to be able to explain, or if necessary, as is often the case over there, to set up and operate any machine which the dealer sells; and this is just where the American representative comes in to advantage, not only for the dealer who handles the line, but also for the customer as well, but principally for the American firm; for in nine cases out of ten where an inquiry is received by a foreign dealer for prices, for example, on American boring mills, or engine lathes, he is representing three or four American firms who manufacture both kinds of tools, and each particular make has its especial merits; but the dealer has no salesman in his employ who is able to call on the customer and discuss intelligently the respective merits of each different make of machine. To be sure, he has a good general knowledge of boring mills and engine lathes, but the chances are that the customer knows just as much, if not more, about the class of machinery he wants, than the salesman does; but where an American firm has its own man over there, he is at once sent out to call on the customer, and it is needless to say that he gets the order, and at the same time, by reason of his complete knowledge of the machinery he is selling and ability to so thoroughly explain its merits, he gains the confidence of the customer; and when this is once gained it goes a long way toward establishing permanent relations, and in the writer's opinion, these few American firms who have maintained their own representatives abroad for the past two or three years, working in connection with their foreign dealers, are the firms who will continue to enjoy a large foreign business. Of course, all American firms who are doing business abroad cannot afford to maintain a representative over there, for the amount of business in their particular line would not warrant the expense; but two or three firms in similar lines might profitably combine in sharing the expense of a man to look after their interests, and the writer is firmly of the opinion that, if American manufacturers would personally investigate the conditions of trade abroad, they could not fail to see the necessity of greater cooperation with their foreign representatives, and to the end of complete cooperation, to send their own American representatives to work in conjunction with their foreign dealers. There has been too much printed about primitive methods of manufacture on the other side, about the ignorance and incompetency of the laboring classes, etc., all of which may have been true enough ten years ago and possibly may still be true in regard to some small sections of the black forest district of Germany, portions of Spain, Italy and Russia; but when it comes to the general manufacturing centers of Germany, France, Belgium or England, there is nothing primitive about either methods or workmen, and the quicker American manufacturers forget that they have ever read such stuff, the better it will be for their interests in a business way abroad; and the best way for this knowledge to be acquired is by a trip through Europe, not to study the old castles on the Rhine, nor the mountains of Switzerland, but to visit foreign manufacturers and study their 'primitive' methods, and profit thereby.

"There are firms in this country, with whom the writer has talked since his trip abroad, who really think they are enjoying a very fine foreign business, and as one manufacturer said, 'we are getting all there is in our line,' but to the writer's personal knowledge, this particular firm is losing more foreign trade every day than they now get in a month, simply because they have never deemed it necessary to make a trip over there, and also because they have, through their wisdom (?), failed to heed the advice which has been given them repeatedly by their foreign agents; and the result is that instead of getting, as they think, all the business there is in their line, the very same articles are being duplicated over there, and manufactured even better than those made here, and it is only a question of a short time when the American firm will find that their foreign business will be no more, and they will then probably condemn their foreign agents for not keeping them informed, but they will be bound to 'sit up and take notice' very shortly, and so will many other good American firms who have deceived themselves into all sorts of beliefs."

8. "Our first suggestion is that American designers and manufacturers must improve their machines in design, workmanship and producing capacities, so that by the time the present machines are copied and in process of manufacture in Europe the newer and better machines will still find sale on account of their superior qualities.

"Our second suggestion is that American manufacturers take carefully into account their ability to sell largely in foreign markets in less prosperous times than the present, and be careful not to unduly enlarge their facilities in these prosperous times, particularly when it must be done on borrowed capital."

9. "I quite agree with you that we American manufacturers have enjoyed a very prosperous business in foreign parts which, as your letter would apparently imply, may not always continue. If not, what shall we do?

"In the first place we are of the opinion that it is highly important that Americans should keep design to the front. In fact, we believe it is *the* strength of American tools abroad. For a long time we have been undersold by foreigners when they have 'caught on,' so to speak, to the excellence of our designs; but progress here is so rapid that by the time they get a machine well under way, our designs are well improved, though, as you know, the gap between us and them is rapidly narrowing. Frankly speaking, it would seem to me that, laying aside the matter of superiority in design, we must contemplate defeat in foreign parts unless our wages shall be relatively nearer to theirs. The cost of living and wages in this country are so great, compared to foreign prices, as to be more marked every year. While this feature is somewhat commented on now, it is bound to be much more dwelt upon when we have a real depression hereabouts.

"We cannot see how American manufacturers can make any move to counteract this, unless it is to have a lowering of our tariff. There are quantities of things, which enter into the purchases of the working classes, which could be bought cheaper if obtained from abroad. Now we are really talking politics, and you want practical business suggestions."

10. "We have realized for some time that some organized measure must be adopted by American manufacturers, and this we believe must be done aggressively, and we do not see how any results can be accomplished unless the assistance of this government is obtained. We believe that the government should establish a bureau to further the sale of American products abroad, especially the metal trades products, as this bureau of the government could then report to the administration, making suggestions as to corrections or modifications in reciprocal tariff arrangements to the advantage of this country, instead of leaving the question of tariff to a lot of theorists in the Senate.

"It is practically impossible for this firm to sell machine tools in Europe, with the exception of those which we make a specialty of, and which cannot be obtained anywhere else, and we have found many instances where the German machine tool builders have sold competitive tools in this country, paying the freight, insurance and duty, still obtaining the order at a lower price than we were able to quote. We likewise understand and know that a number of the foreign agents are interested in machine tool manufacturing companies in their own countries; this is naturally a detriment to manufacturers in this country."

11. "Some will think it best to favor the home trade in good times like these to the exclusion, if need be, of the foreign; others will nurse the foreign business, and even favor it somewhat, with the idea of having it when business drops off in this country. It may be possible for some manufacturers who make special machinery which, on account of its novelty, has little competition, to neglect the foreign business in these times, and still, when they need it again, be able to go on the other side and build up a trade without much trouble.

"We do not believe the regular manufacturers of machine tools can afford to do this. Our policy has always been to

treat the foreign business just the same as though it were home business. We do not favor it to the exclusion of home business, nor do we favor home business to the exclusion of the foreign; but we give it just exactly the same consideration that we do business received from this country and no more. The result is that we are taking care of our foreign agents just as well as we are our home agents, and although we are behind on deliveries, just as everyone else is, we are not treating our foreign agents any worse than the agents in this country.

"We believe that we could obtain more foreign business if we were making a special effort to get it, but as we are unable to take care of the business we are now getting and make satisfactory deliveries, we are not just at present making any special effort to get more. We believe that manufacturers who are now ignoring the foreign business they had before the boom struck us, will find it hard to get this business back again, for the machine tool builders abroad are fully awake to modern improvements in design and methods of manufacture, and that while we still lead them slightly, they will not be slow in catching up.

"When the writer was abroad three years ago, he found considerable complaint among the dealers, especially in Germany, on account of the manufacturers having done this very thing during the boom in 1900. The result was that tools made by these American manufacturers were then being made abroad, and the market had been utterly lost in certain sections for the Americans.

"We think the only policy to pursue with foreign dealers is to give them a square deal just as we do our own home dealers. We do not see how we can do any more than this without making hard feelings at home; nor do we think we should do anything else, because that would be treating our foreign agents unfairly.

"When business gets quiet in this country we shall undoubtedly make a stronger effort to get some business abroad. This we might accomplish by sending representatives from this country over on the other side to assist our agents there, as that method usually results in an increase of business.

"We do not dare to pursue this policy now, because we do not want to stir up business and take orders which we cannot fill, therefore we are following the policy of lying low for the present."

12. "You are, of course, aware of the attempt made some time ago to induce the authorities at Washington to send abroad experts in the machinery business to supplement the work of our consuls, and this in the writer's opinion will be one of the greatest helps toward an increase, or at least a continuance, of our present volume of trade abroad. Therefore anything which you can do through your publications or otherwise to create a public opinion in favor of such a move would be highly desirable."

13. "We are fully satisfied that the conditions abroad are changing very rapidly. That is, the foreign manufacturer of tools is waking up to the fact that the Americans have had a monopoly on this business for a great length of time. We have discovered to our sorrow that anything we make in the way of an automatic screw machine, and sell in large quantities in foreign countries, has been duplicated in almost every instance where we have not been protected by patents. The only solution we can possibly see to offset this condition is to keep on improving our machines and, if possible, obtain patents on everything of any consequence; but the great trouble is that it is possible in a great many cases to improve a tool in various ways and still not add anything that is patentable; and, in such cases as this, it would seem necessary for us at all times to keep on thinking of something to add to our tools, so that the parties who steal our ideas on the other side will always be trailing as regards the latest design.

"When we obtain a patent in a foreign country, especially in Germany, it is necessary, according to their patent laws, that we should manufacture in that particular country in three years from the granting of the patent. You can well understand that in order to keep up with this kind of a game it would be absolutely necessary for us to manufacture our machines on the other side. You cannot fool them by sending along parts of machines to have them assembled. You have got to show them that you are actually manufacturing in good faith in the country in which the patent has been obtained.

"Just as soon as the foreigner develops to the extent of being able to produce fully as good a tool as the American, there is no question in our minds but that it will be almost impossible for us to keep on doing business in foreign countries. The only reason, as we understand it, why our business has been so extensive is because the workmanship on American tools is much superior to that on foreign tools; but we well know that this cannot continue, as the foreigner is waking up to the fact that there is a large business to be had if he can turn out as good a tool as he is now importing. We have no great fears at this particular time that our business is going to drop off on this account; but before many years we shall certainly suffer for the very reason that in Germany, where we sell a great amount of our product, they are progressing very rapidly and manufacturing some very good tools of all descriptions at this time.

"To sum this whole matter up: It seems absolutely necessary that the American tool builders should keep on improving at all times so that their foreign agents will have something of importance to talk about; and, as we said before, in the matter of patent protection we are not so secure in retaining our business for the reason that when you design a new machine, or an attachment for same, and apply for a patent at once, should you obtain this patent in what you would call a reasonable time, there is a possible chance that you would not be in shape to market this particular tool, or attachment, for perhaps a year or more after you obtained the patent, leaving you, say, but two years in which to work the business before the foreigner could steal your ideas; and it is not always the easiest thing in the world to add new ideas to your product in order to keep up with anything of this kind."

14. "It would seem obvious that any manufacturer or dealer, for that matter, who does not look after his customers, whether they be domestic or foreign, is bound to lose them in the end, and an effort to take collective action in some way to wake up sleepy heads to their own interests would seem to be about on a par with the effect of the labor union to establish a minimum wage; that is to say, it would be hard on the part of the capable to drag along the incapable. We believe the cases are exactly parallel.

"It may not be uninteresting to state our own position with regard to trade, and when we say trade, we mean domestic and foreign both. Our position is just this, to make the best machinery we know how to make, sell it at a profit if we can, treat our customers with absolute fairness, whether they are at home or abroad, to increase our capacity so as to keep our deliveries about the same under all conditions of demand, and all of this without the slightest regard to what anybody else does or how he does it.

"To make a concrete illustration of this, we may say that we have raised our price only 5 per cent during all of this so-called boom, and this has been made to apply to all of our trade, whether domestic or foreign. We have kept our deliveries good at all times. We are making deliveries now from five weeks to ninety days from date of receipt of order, according to the size of the machine to be delivered.

"With especial regard to foreign trade we may say that we have our foreign agents all over the world. Some of them have been with us eleven years, but we don't suppose they will continue selling our American machines one moment after they can deliver machinery made in their own countries that is just as good and just as cheap; they would be very foolish if they did. We always recommend an American machine to an American if he inquires of us about it, and we cannot see that it is any crime in a German, or Englishman, or Frenchman to recommend the product of his own country as often as he has an opportunity.

"The only way we can see to hold our foreign trade and to increase it, is to make good goods, better than they can get anywhere else, make them for less money than anybody else can make them for, and to deliver them promptly."

15. "When the writer last traveled through Europe, he was convinced that the time was not far distant when the home makers would be able to supply the demand for all the standard tools. This condition, however, has not yet arisen, but it would seem as if they should be able to meet American competition in this respect. Our suggestion would be that the American makers study the requirements of the market more fully, and endeavor to supply machines which will be better adapted to meet these conditions than their regular product. Moreover it would seem advisable that American makers should affiliate themselves with selling agents who would use their endeavors to further the selling of the American product, and who would not use their connection with American firms to develop the manufacture of such tools at home. Secondly, it is desirable that American manufacturers should be allied with concerns who can and will carry a reasonable stock of machine tools for immediate delivery, and who would, if necessary, be prepared to carry a limited supply of their repair parts for standard machines.

"During prosperous times a continued effort should be put forth to secure European business, and the European market should receive as prompt deliveries as the home market. We also think that every manufacturer should insist on knowing to whom his machines are sold, in order that he may be able to supply repair parts promptly, and that there may be no delay in taking up matters regarding the operation and care of his machine."

16. "The most successful way we know of is to have good American mechanics who thoroughly understand the machine tool business, and also posted on the foreign demands, who can speak foreign languages, to go over there and sell our goods."

17. "During the past ten years about fifty per cent of our product has gone abroad, and naturally we take great interest in this trade. Under the present conditions we could

of course sell our entire output in the foreign markets, but it would not be policy for us to do so.

"In regard to the price question, we have studied this closely, and we think this question will be an important one in the foreign trade when business drops off in this country. We believe as you do that there should be some systematic effort on the part of tool builders in this country to meet conditions for the future as regards this trade. We ourselves are governed somewhat by the action of our competitors at the present time. We have always tried to sell to the foreign trade at as low a price as possible, with a fair margin of profit, not considering the condition of general business. We think this action is the cause of our success with the foreign trade."

18. "Having been associated for over twenty years with the best foreign agents, we are of the opinion that we are better represented than other manufacturers who have taken on their foreign business at a comparatively recent date. Of course the annual trips made in the past by Mr. M—— have kept us in better touch than we could possibly be by correspondence. Our past experience in handling foreign trade has taught us that foreign prices cannot be raised and lowered the way they are in this country, for the reason that most foreigners are suspicious of the motive that prompted the change, and they think if you raise your price that you are trying to 'squeeze' them, or that you don't want their business; while on the other hand if you lower them they think you intend to send another machine than the one you bid on. We have had foreign customers refuse to accept a cut of a tool, insisting on an actual photograph, saying that cuts could be altered and photographs could not.

"We have been very slow about changing our prices; when changing, we have done so only for the best of reasons. We have also shown our agents that they are getting their fair share of our production, and that while they are not getting all they would like, they understand that there is no discrimination made. About a year ago, anticipating somewhat this present boom, we looked up the average amount of business done by each agent, figured out our probable production for the next year, and then we wrote each one just what they had sold, what we could do and what they could expect, with the result that we never had a more satisfactory foreign business than we have to-day, and at the same time we have not injured our home trade.

"We thoroughly believe in foreign trade, as it has helped us out at times when other manufacturers were slack; but we think that more judgment must be used in changing prices, designs, etc., than in handling our domestic trade."

19. "It appears to me that there are four conditions which will lead the foreigner to buy our goods; cheapness, activity in pushing our goods, merit, and quality of workmanship. We cannot hope to beat the foreign manufacturer in either price or in activity in pushing the goods. Our hold on the foreign trade, then depends, in my opinion, upon quality of workmanship and merit of the designs. The foreign market would be small for the manufacturer who has not original designs and very high workmanship to offer. Of course, there may be times when the foreign work-shops will be so filled with orders that the United States will catch the overflow. This was the condition prior to 1900. Since then the foreign trade has disappeared for all except the few who had something to offer which the foreigner could not get at home.

"If the conditions in this country were such that the buying power of the dollar were more than it is now, we might be able to reduce the wages of our men without depriving them of any of the comforts which they now enjoy, but so long as we continue to support artificial prices in all the necessaries of life by a prohibitive tariff, any reduction in wages is out of the question."

20. "While the foreign countries are working hard to supply their own domestic demand, the reputation of our machine tools is such that we can command a higher price right in their own country. How long this condition of affairs will last will depend upon how far we can keep ahead of them in producing a superior article. The only way that we can maintain possession of what foreign business we have, is through superior quality and moderate price. Quality, I think we need have no fear of. Price is a question which, at the present time, seems to be considerably beyond the control of machine tool builders in this country. With pig iron selling at 50 per cent more than it did a year ago, and labor an average of 15 per cent higher, copper, brass and bronze nearly 100 per cent higher than recently, there is no option left to the machine tool builder but to raise his price.

"To illustrate this point, we call attention to one size of machine tools which we manufacture, which a year and a half ago sold for about $2,000. We have raised the price to $2,500, and the result is that our customer pays 25 per cent more for the tool; our agent makes 2½ per cent more and we make 3 per cent less profit than before the price was raised, based on the former selling price of $2,000. This is in spite of all the modern ways and means we can devise for reducing the cost of manufacturing.

"From my standpoint, I can see no excuse for the present high price of raw material in this country, excepting that there is a large demand. It will kill the goose that lays the golden egg unless relief is found, and that quickly."

The suggestions contained in these letters, and our own experience based on personal investigation in Europe, indicate the following points as most important:

1. Frequent visits abroad so as to keep in close personal touch with conditions there.
2. The same care and attention to foreign orders as to domestic.
3. Absolute adherence to promises of delivery, etc.
4. Care in carrying out shipping directions.
5. Infrequent changes in price.
6. Advancement in design, and, if possible, reduction in cost through improved methods of manufacture or otherwise.
7. Missionary work abroad by your own travelers, if your business warrants it.

To these we add our strong opinion that free raw material is absolutely essential to preserve our foreign trade in machinery.

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SHORT POSTAGE ON FOREIGN MAIL.

Short postage on letters to foreign countries is a serious matter for American importers and others who would establish satisfactory foreign relations. Many complaints are made of the carelessness of American correspondents in this regard, and although apparently a trifling matter, it is one of those things that goes a long way toward fixing in the minds of those whom we would please the opinion that our business methods are quite lax. When a firm is carrying on an extensive foreign correspondence, "postage due" may be a considerable item, for when a letter is mailed to a foreign country with insufficient postage, the amount due is doubled, the recipient being obliged to pay two rates and, in effect, is fined for the carelessness of one who perhaps is a total stranger to him, having no particular claim to his courtesy. The latest complaint that we have noted in the U. S. Consular reports is that of Consul-General Samuel M. Taylor, Callao, Peru, in which he mentions a particularly aggravating incident. A Peruvian gentleman received from a business man in the United States a letter short of postage, but the letter was accepted and the postage paid. The entire subject matter concerned the interests of the American, being a letter of inquiry. A letter containing valuable information was sent in reply, in which incidental reference was made to the short postage that the writer had to pay. His American correspondent wrote a profuse letter of thanks and apology, assuring him that such an accident would not happen again, but the letter of apology was itself short of postage!

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TO DETERMINE ACTUAL PLANER SPEED.

The following is taken from a catalogue describing the high-speed planers made by Bateman's Machine Tool Company, Ltd., Leeds, England: "The old practice of judging the comparative values of planing machines, by comparing their speeds on cut and return, has been found very misleading. This is because of the momentary stoppage of the table at each end of the stroke and the time lost before full speed is attained after reversal. In some machines these losses are very considerable and materially reduce the productiveness of the tool, and if such machines were sped up, the loss on reversal would be enormously increased. The only accurate means of ascertaining the earning capacity of a planer is to take the cycle time, as indicated below.

Time of cycle = time of 1 cut + time of 1 return.

L = length of stroke in feet.

T = time of N cycles in seconds.

N = number of cycles.

$$\text{Average (or earning) speed} = \frac{2L \times N \times 60}{T}$$

Thus a 42-inch by 14-foot machine completes 10 cycles in 3 minutes 56 seconds (236 seconds) when on a 14-foot stroke.

Therefore, the average speed is $\frac{14 \times 2 \times 10 \times 60}{236} = 71$ feet per minute."—*American Engineer.*

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

Water wheel units of 12,000 horsepower each will, says the *Engineering News*, be used to drive electric generators in a power transmission plant at Vallecito, on the Stanislaus River, California. The water units, it is claimed, are the largest thus far attempted. The water will be transmitted to San Francisco and other large centers.

The United States Steel Corporation will build a $6,000,000 blast furnace plant at Duluth. This move is of much significance and doubtless will have a great influence on the future of Pittsburg and other Eastern plants as well. The tendency is to avoid the long haul of raw material, and to transfer the conversion operations to as near the source of material as possible.

According to *Railroad Men*, the Chicago and Northwestern Railway has decided to use fuel oil instead of coal on all its locomotives in the Wyoming district. The company is sinking wells for the production of its own oil in oil lands near Casper, Wyoming. At the present time all the coal used on that division of the road has to be hauled a distance of 900 miles.

At the steel works of the International Harvester Co., in South Chicago, an exhaust steam turbine of the Rateau type has recently been installed by the Rateau Steam Generator Co., Chicago. The exhaust steam from a reversible blooming mill engine is utilized for the turbine. The exhaust from the mill engine is intermittent, and the steam is therefore taken through a regenerator. It is understood that the installation proves that in the exhaust of an average reversible blooming mill engine there is power available to furnish from 1,000 to 1,500 K.W.

The return of the British battleship *Dreadnaught* after a cruise of 10,000 miles at an average speed of 17 knots seems to demonstrate the reliability of steam turbines for battleships. The *Dreadnaught* is the first battleship provided with steam turbines, and for this reason the trial cruise has been watched with great interest by all concerned in ship building, as well naval as commercial. While there doubtless has been a great deal of information gained during this trial cruise, it is not likely, however, that much information of value will be given to the public, in view of the policy of the British admiralty of keeping such information secret.

A concrete building in Milwaukee recently went through an accidental test which amply exhibits the stability of such construction when properly executed with good materials. The *Engineering Record* mentions that an explosion of acetylene of such violence occurred in the building that everybody within was either killed or injured, and all windows, doors and woodwork were blown to pieces. An examination of the structure revealed no crack or blemish anywhere in the concrete. As the effect of such explosion on brick and timber buildings has proven to be very destructive, it makes the showing for this concrete structure all the more creditable.

Considerable sensation was created in the early part of May by the published announcement that Sir William Ramsay, Cambridge University, England, had communicated to the Johns Hopkins University, Baltimore, the news of the discovery of a synthetic process for making copper from the elements sodium, lithium and potassium, by treating them with radium vapor. It was alleged that the resulting product was copper sulphate, which, of course, is readily "broken down" into copper. As might be expected, Sir William immediately denied the alleged discovery in positive terms, so the fond anticipation of those who would smash the copper trust are not likely to be realized immediately from this source, at least.

Commenting upon the projected new elevated railroad across Berlin, Germany, which will be constructed on the suspension principle, the *Archiv für Post und Telegraphie* gives an interesting account of the successful railway between Barmen, Elberfeld and Vohwinkle in Germany, which is constructed on this principle, and which is regarded as a daring example of German engineering skill. This suspended railway has so far proven to be one of the safest railways in the world, since no passenger has ever been either killed or injured. Over, or rather under, this suspended railway 414 trains travel every day, carrying in a year more than 12,000,000 passengers. Weather conditions do not interfere with the traffic, and the motion is singularly agreeable and noiseless. The suspended railroad across Berlin will be 7½ miles long with fifteen stations. This distance will be traversed in 22 minutes, including stops, and the fare will be a trifle less than four cents.

The new artificial rubber, called "Zackingummi," to which we referred in our engineering review in the March issue, has, according to *Stockholms-Tidningen*, proven to stand up well to the tests to which it has been subjected. The results have been particularly satisfactory when using the new material for automobile tires. At the present time more than a dozen automobiles and motor wagons in the Swedish capital are provided with tires of this kind, and the users have found the Zackingummi stronger than ordinary rubber for this purpose. It has also been used for flexible gas pipes, erasers, etc., and proven to possess all the qualities of the natural product. Large factories for the commercial exploitation of the invention are to be built this summer. The price of the new article will be materially less than that of rubber. Patents are already secured in the Scandinavian countries, France and Austria, and are pending in all other civilized countries.

It undoubtedly will surprise many to hear that Benjamin Franklin is to be one of the donors to a trade school so long after his death. However, a trade school known as the Franklin Union is to be built in Boston, and to be erected and maintained by the fund left to the city of Boston by Benjamin Franklin, which fund matured and became available for use some time ago, and which has been doubled by an endowment from Andrew Carnegie. The proposed school will be four stories high, built of brick and stone. In the basement it will contain a model boiler room, a steam and hydraulic laboratory, an electrical laboratory, an automobile laboratory, and a clay modeling room. The upper floors will be devoted to chemical and physical laboratories, exhibitions and class rooms. A large lecture hall and library will also be provided. It is expected that the school will be used mainly for evening work, thus affording an opportunity for young men employed during the day to obtain a technical education along the line desired.

The *Valve World* states that the unusual demand for structural steel in San Francisco has reached far beyond the borders of the United States, and that owing to cheap ocean freight rates Scottish producers of steel are selling structural steel in San Francisco in competition with American makers. Although the ocean freight rate is about $6.00 per ton, the Scottish steel plants are able to place the finished structural steel in California at the same price as that at which American steel mills are willing to sell theirs. The plane which American steel manufacture has reached undoubtedly permits the production of steel to be carried out as cheaply as steel can be manufactured in Scotland, inasmuch as improved machinery and modern systems and appliances in almost all cases by far outweigh the difference in wages paid in this country and abroad, and it is very safe to say that if it were not for the tariff, our gigantic steel interests would be able and willing to sell their product far below the prices now charged, without suffering from being unable to get reasonable returns on the capital actually invested in the steel business.

An interesting description of a machine for making weldless chain by the rolling process, and photographs of the product, are shown in the *Iron Trade Review*, April 4, 1907. The Weldless Chain Co. of Chicago is in possession of the patent rights of the machine, which, it is claimed, produces a chain equivalent to a forged steel chain. The chain is made directly from a bar of steel at a rate of 3 feet per second, and when tested at the United States Navy Yard a ⅜-inch chain proved to be able to stand up to a strain of 7,330 pounds, which performance, although the test piece in this particular case was slightly imperfect, is even better than many test records of welded chain. The principle of operation of the machine for making the chain depends upon the simultaneous impression of four dies or rollers acting at right angles to one another, each of the rollers being beveled to a 90-degree angle. On each of the beveled faces four endless dies are cut, continuing around the entire circumference of the rolls. The chain is rolled from a round bar, and when coming out from the rolling operation, is fully finished, with the exception that it has fine metal webs on the sides, which have not been fully cut off during the forming operation. These webs, however, are easily removed by putting the chain through a tumbler. In finished condition the chain is about three times as long as the original bar.

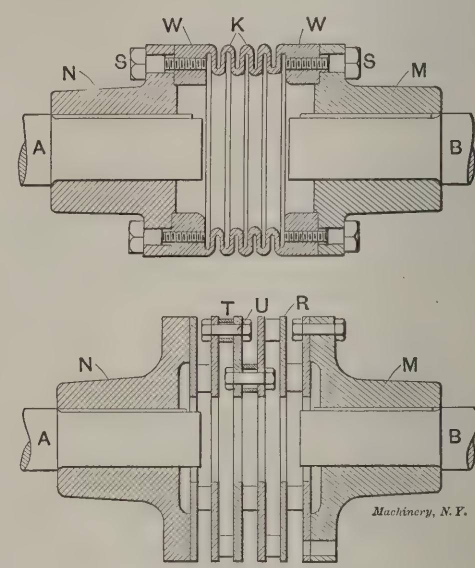
The *Industrial Magazine* calls attention to the interesting fact that concrete construction is not so new as many persons suppose. Although it is comparatively new in this country, and has not been used to any great extent during the last century in Europe, still concrete construction itself has been known at least for 4,000 years back by the ancient Egyptians and Romans, and it was more commonly used than natural stone. The pyramids, which have been the wonder of all ages, are covered with concrete. The Hebrews also knew the properties of this material, and near Jerusalem there are aqueducts and bridges of concrete, many of which are used to-day. Nearly all of these are in better condition than similar structures of brick which have been built during the past half century. There are concrete buildings in Rome which are claimed to have been in use for more than 1,400 years. In England and Ireland there are concrete castles and towers still standing, which were erected during the Roman invasion of England nearly 2,000 years ago, and as concrete possesses the quality of becoming harder with age, these constructions to-day are more solid than they were at the time when they were built. With such a record for durability, it is no wonder that modern building science should examine the merits of this building material. The idea of reinforcing concrete with steel evidently belongs to our age, and herein lies a great development in concrete work.

The experience of the Italian government with the Valtellina railroad having been particularly satisfactory, a new railroad for exclusively electric traffic, 85 miles long, is to be built between Genoa and Milan at a cost of $47,000,000. A report from Consul J. E. Dunning gives some particulars about the construction and operation of this road. The complete line will have 19 tunnels, the most important of which will be 12 miles long. The line will be double tracked, and the trains hauled by electric locomotives. These will be able to operate at a speed of 54 miles per hour on gradients of 0.8 per cent, and at a speed of 80 miles on the level. The passenger trains will be composed of three passenger cars. Express trains will run every two hours from 4 o'clock in the morning to 12 o'clock at night and make only one stop. Local trains will be run between the express trains so that in all there will be 20 passenger trains per day in each direction. The locomotives for the freight trains will be capable of pulling 30 freight cars, each car weighing 22 tons. These trains will run at a speed of 20 miles per hour on inclines, and 35 miles per hour on the level. There will be no grade crossings on the route. If this railroad, when completed, proves a success from a financial point of view, it will have demonstrated beyond doubt that electric power for regular railroad operation is not only possible, but highly desirable.

BROWN-BOVERI FLEXIBLE SHAFT COUPLINGS.

The Mechanical Engineer, February 16, 1907.

The accompanying cuts show an improved flexible coupling manufactured by Messrs. Brown, Boveri & Co., Baden, Switzerland. In the upper cut *A* and *B* represent the shafts to be connected, and *M* and *N* are coupling flanges keyed to the shafts. The coupling itself consists of a steel cylinder *K*, which has a corrugated or undulated shape produced by turning grooves alternately on the outside and the inside surfaces. There are annular enlargements *W* on both ends of this corrugated cylinder which receive bolts or studs *S* connecting the cylinder on both sides to the coupling flanges *M* and *N*. The lower cut shows a modification of this construction in which the cylindrical connecting body is composed of individual flat disks *R*,



Flexible Shaft Couplings.

which are connected to each other by distance pieces *T* and bolts *U*. The latter are so arranged that connection of two following disks is effected alternately at the exterior and the interior of the coupling. This provides for the necessary elasticity. The end disks are secured at both sides to the flanges *M* and *N*. When using the solid corrugated form the coupling flanges may, if preferable, be inserted on the shafts in the reverse way from that shown in the cut, and thus a greater length of corrugated connecting cylinder, and consequently more resilient coupling, may be obtained without altering the condition of the shaft; the corrugated cylinder in this case encloses the whole coupling.

RESISTANCE OF WOOD TO SHOCK.

Little study has been given to the resistance of wood to the action of impact loads, such as result when a locomotive passes over a wooden trestle. The Forest Service of the United States Department of Agriculture has been studying the sub-

RESISTANCE OF WOOD TO SHOCK.

	Natural Wood.		Wood Steamed Four Hours at Twenty Pounds.	
	Static.	Impact	Static.	Impact.
Number of tests	8	8	8	8
Annual rings per inch	7.5	7.5	6.5	7.0
Per cent of moisture	13.8	13.1	13.4	13.1
Specific gravity	0.558	0.550	0.546	0.537
Deflection in inches at elastic limit	0.31	0.67	0.34	0.67
Fiber stress at elastic limit (pounds per square inch)	6,496	15,018	6,380	13,490
Modulus of elasticity (1,000 pounds per square inch)	2,061	2,150	1,829	1,894
Modulus of resilience (inch pounds per square inch)	1.164	5.88	1.241	5.36

ject at the timber-testing station at Purdue University, Lafayette, Ind., and finds that wood is more elastic under impact than under gradually applied loads. This would go to show the wisdom of locomotive engineers in taking a weakened

trestle at high speed. Air-dried loblolly pine specimens, both of natural and steamed wood, 2 by 2 inches in cross section, were tested in bending on a 34-inch span under both impact and static loadings. The moisture content was approximately 13 per cent of the dry weight, or about the moisture condition of air-dry wood. The machine and methods of test are described in Circular 38 of the Forest Service, "Instructions to Engineers of Timber Tests." The maximum deflection under a gradually applied load was 1.2 inch, and the deflection just preceding failure under impact was 1.1 inch. There is, thus, little difference between the ultimate deflection of wood under the two kinds of loading. But at the elastic limit the average deflection under gradual loading was 0.33 inch, while the average deflection under impact loading was 0.66 inch. Thus this wood possesses twice the elastic strength under impact that it does under static load. The detailed tests upon which these statements are based are presented in the table on the preceding page.

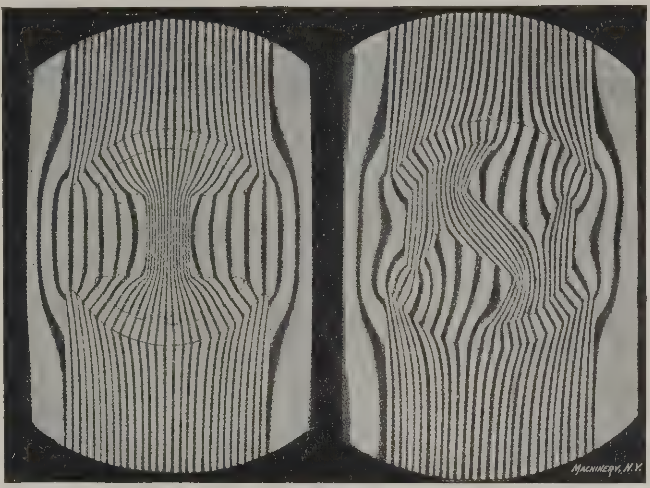
TENSILE-COMPRESSION STRESS IN REINFORCED CONCRETE.

Times Engineering Supplement, February 27, 1907.

The very considerable advantages secured by embedding small bars or sheets of steel in a mass of concrete, on which are based the various systems of "ferro-concrete" construction, were for a long time imperfectly understood, and it was not until it had been demonstrated by careful tests that reinforced concrete acquired by this means a degree of tensional resistance vastly superior in all cases to the strength of either material used alone, that this system of employing concrete became widely appreciated. The above properties depend largely upon the amount of adhesion between the steel surface and the concrete incrustation, and inventors have displayed considerable ingenuity in devising means for corrugating the steel armoring, in order to improve the grip or hold of the concrete. It has been shown that in all positions the steel under tension tends to maintain the concrete in a state of compression, and as the tensile strength of the steel enormously exceeds that of the concrete, while the latter exerts its best effects under compression, both materials are placed in a position to take any required stress under the most favorable conditions for exerting their full force. The knowledge of the actual stresses that occur in ferro-concrete is not yet complete, though important facts were made known by Considère in a series of tests conducted with prisms of concrete, some of which were formed with metal cores and some of concrete alone. He was able to show that in the case of the reinforced concrete the expansion was much less than in those test pieces wholly formed of cement, and he was thus able to estimate the enormous strain exerted on the core by the surrounding concrete, which must necessarily have been under compression, while the steel core, in order to resist expansion, must have been in a state of tension.

SEEING AND PHOTOGRAPHING INVISIBLE PHENOMENA.

The possibility of studying phenomena visually, which by their very nature are invisible, is a very interesting development of modern science. The accompanying half-tone shows the lines of induction in the magnetic field of a Siemens shuttle-wound armature in two positions. Now, of course, magnetic action is totally invisible, and the photograph is not a photograph of the actual lines of force, but of an entirely different medium which acts in an analogous manner. This view was one of the illustrations of a paper read by Dr. H. S. Hele-Shaw before the Junior Institute of Engineers, January 16, 1907. It was discovered some years ago by this versatile investigator and his collaborators that water flowing in a restricted channel follows certain mathematical laws which also apply to the distribution of lines of force in a magnetic field, the conduction of heat and the flow of electricity. After a long course of experiments it was found that the flow between thin glass plates could be made visible by the admission of bubbles of air which, following the same flow lines as the water, produced light and dark streaks or "color bands" in the water. The introduction of obstacles gave in each case a characteristic form of flow, and by ingenious arrangements a great variety of action has been imitated and made visible. In all cases the narrower lines show areas of low pressure and high velocity and the broad lines show areas of high pressure and low velocity. In the case of the armature views it will be noted that the lines of magnetic force flow freely through the middle solid part of the armature connecting the two poles, but through the air spaces there is a great increase of resistance, this being indicated by the broad bands. The change in effect due to shifting the position of the armature is illustrated in the right hand view.



Lines of Induction in the Magnetic Field of a Siemens Shuttle-wound Armature.

In this manner the magnetic flux in tooth core armatures with wide and narrow air-gaps has been investigated; also the effect of various shaped rudders on stream lines on ocean vessels, and many other objects of analogous nature. In the case of the magnetic flux distribution it has been visually demonstrated that a very narrow air-gap is not desirable, and the same conclusion has been reached by the manufacturers of electrical apparatus. At one time it was supposed that the narrower the air-gap the better the efficiency, but such has been shown by practice and theory not to be the case.

DEVELOPMENT OF THE MACHINE TOOL INDUSTRY.

Bulletin 67, Department of Commerce and Labor.

The census of metal-working machinery, 1905, prepared by Mr. Fred. J. Miller, expert special agent, gives an interesting account of the development, and a comprehensive and condensed idea of the status and possibilities of American machine tool manufacture.

American Tools in Foreign Markets.

There is hardly any manufacturing center in the world where there are not factories which are wholly or partly equipped with American built machinery. It is largely through the use of highly specialized methods of manufacture that American makers have been and are able to compete with the products of European shops. Whatever the cause underlying the superiority of American machinery, whether higher grade of labor, greater incentive for machinists to suggest improvements on the machines they use, or the fact that many machinists have become manufacturers, or for all these reasons combined, the fact remains that American tools are used extensively in foreign countries, and their value recognized. One of the greatest obstacles to the growth of the foreign trade in machine tools has been the difficulty of adjusting American tools to European shop methods, or making the European mechanic used to the American tools. The influence of one upon the other is seen in the modification of American machinery to meet European demands, and the gradual change in European shop methods to meet the requirements of American machine tools.

Specialization in Manufacture.

The most important feature of the development of the machine tool industry is the specialization in manufacture that has taken place in recent years. This specialization has grown to such an extent that there is at present not a single estab-

lishment in the United States in which a complete line of metal-working machinery is constructed. In this practice American builders have pursued a policy widely different from that of foreign builders who usually are ready to undertake the manufacture of any machinery required by a customer. The tendency in the United States is toward still greater specialization, and there are indications in Great Britain and on the continent that this plan will be adopted there also. The progressiveness of American machine manufacturers to undertake to build new and specialized machinery, however, is shown in their readiness and ability to manufacture special machinery for the bicycle and automobile industries.

High-speed Steel.

The invention of high-speed steel has had a most remarkable effect upon the development of metal-working machinery. The adoption of this steel has led to important modifications in certain metal-working machines, especially in lathes for heavy work. One of these modifications has been the redesigning of the driving mechanism of the lathe to make it capable of enduring the stress of the greatly increased speeds. Another modification has resulted from the fact that systematic tests, made to show just how fast a heavy cut could be taken, have led to a change of ideas as to what constitutes a heavy cut, and to a demand on the part of machine tool users for machines that will not only endure the higher speeds called for by the new steels, but will carry heavier cuts than formerly thought practicable. The use of high-speed steels has resulted in a considerable reduction of the cost of removing surplus metal, particularly from forgings. This has led to some misunderstanding as to the total net effect of the use of high-speed steel, the fact having been overlooked that in the construction of many kinds of machinery the chief item of expense is not the cost of taking heavy cuts, but the cost of the finishing process which involves the taking of light cuts, careful gaging, grinding, hand-scraping and other operations performed by skilled men. The cost of the finishing processes has been reduced but little by the use of high-speed steel, and in many cases they constitute the principal item of cost.

Speed Adjustment.

The use of high-speed steel has led to a much closer scrutiny of the feeds and speeds, and has thus greatly stimulated the development of speed-changing devices. Within the past five years there has come the development of a number of devices by means of which the operator, by merely shifting a lever, alters the speed without stopping the machine or shifting the driving belt from one to another position upon the pulleys, and without changing the speed of the driving belt itself. Some of the geared head developments are capable of imparting to the work not only a greater total range of speeds, but the changes from a given rate to the next higher or the next lower are by much finer gradations. Electricity has played an important part in the development of speed-changing devices. Many machine tools are driven by direct-connected motors, the motors in some being incorporated as an integral part of the design, while in others they are merely attachments. The motors themselves are arranged to run at varying speeds, and additional speed variation is obtained by gears manipulated by shifting levers.

Portable Tools.

The five years included in the census have seen a greater development in portable tools than any previous five-year period. These tools are portable in the sense that traveling cranes may pick them up and carry them where they are wanted. Instead of being constructed of such size and power as to enable them to take large castings or forgings within themselves, they are designed only to hold, direct and drive the cutting tools, the work to be operated upon being held stationary upon floor-plates. These portable tools are driven mostly by electric motors, and a number of machines may be used simultaneously upon one casting, so that boring, drilling, slotting, milling, key-seating, for instance, may all be done at one time, each operation being independent of the others. One of the latest and most interesting features of such work is the practice of setting in position both the work and the tools by means of a transit, similar to that employed by civil engineers in surveying, but made with considerably greater refinement. This enables the attainment of a high degree of accuracy where the allowable limits are stated in thousandths of an inch. These methods in turn have raised the standard of accuracy, so that in large electric generators and similar heavy work a degree of accuracy is now attained that would have been impracticable a few years ago.

Automatic Machinery.

Machines originally designed for making screws, but more recently employed for making a multitude of small machine parts and other articles, and known to the trade as automatic screw machines, have been considerably developed during the period covered by this report. These machines now handle steel bars up to 6 inches in diameter and are used for an endless variety of small parts. A better name for such machines would be automatic turret lathes, as their present function is not merely to make screws, but also to do lathe work. An important addition to the automatic screw machine is the magazine attachment by means of which castings or small forgings are fed successively to the machine. The variety of automatics known as the multiple-spindle automatic has, in particular, been greatly developed. In this machine there are now as many as five spindles, each holding and driving a separate bar of stock to which the cutting tools are presented simultaneously for action. This means that a piece of work made by as many as five distinct operations may be completed on this machine in the time required for performing the longest operation, because the tools used for performing the four shorter ones complete these before the operation requiring the longest time is done. In another machine of the automatic class which is still in the process of development, compressed air is used for moving the various parts of the machine in order to present the tools consecutively to the work and for the motions necessary for cutting operations. The extreme speed of action of air, as compared with the mechanisms ordinarily employed for this purpose, enables the motions usually designated as idle motions to be made much more quickly than is otherwise possible, and thus the time consumed in the withdrawal of one tool and the presentation of another is greatly reduced. Such improvements as these, however, do not materially reduce the labor cost of producing the work, but they reduce the cost by giving a greater product with a given investment in machinery and tool equipment and within a given area of floor space occupied. This reduction forms in many cases a considerable proportion of the total cost.

Compressed air seems likely to be used very extensively as machine tools are developed. The facility and rapidity with which it can be conveyed and its small mass make it well adapted for use in metal-working machinery. In cases where its extreme rapidity needs checking, a check is applied by the use of a body of water or oil which is forced by the air pressure through a restricted opening, and which in turn acts upon the mechanism to be moved. The liquid, by resisting sudden changes in its rate of flow, regulates the speed of the motion.

Grinding Processes.

The process of grinding, which was formerly applied only to parts to be finished true to size, when such parts were made of steel and hardened, has of recent years been developed and applied much more widely than before. It is now used for finishing cylindrical parts of all kinds. Marvelous results in grinding have been obtained by applying great power to driving a relatively large and heavy abrasive wheel which at every turn is made to sweep over the work the full width of the wheel. For instance, in refinishing locomotive piston rods that have become badly worn, a special grinding machine of this kind does the work more quickly, and at the same time with greater precision, than possible by any former methods.

Interchangeable Manufacture.

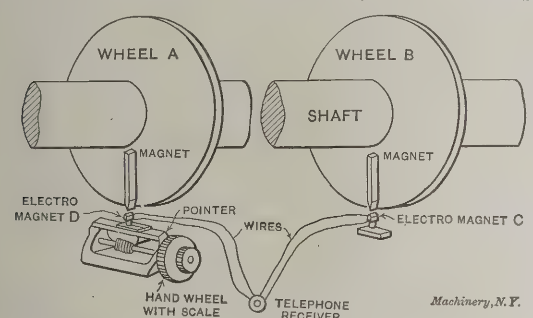
As a result of the specialization in machine tool manufacturing, interchangeability has become an adopted policy. The extent to which this plan is used in a given shop depends, of course, mainly on the number of identical machines to be

built at one time. On account of the different conditions in different shops in regard to the mass of production a great difference in practice exists. For instance, shops building large lathes in small numbers, for which tools and fixtures are more costly, soon reach a point at which the proportionate cost of tools becomes prohibitive, and in such cases it does not involve any saving to build on the interchangeable plan. However, interchangeable manufacture in the production of metal-working machinery is one of the most prominent, important and interesting features of the business as now carried on. Even some of the very largest machines which a few years ago were built one at a time, and only to order, are now manufactured in considerable numbers by the aid of special tools and fixtures, and many, if not all, have their parts interchangeable.

TORSIOMETERS AS APPLIED TO THE MEASUREMENT OF POWER IN MARINE TURBINES.

Archibald Denny, in *Mechanical Engineer*, April 6, 1907.

The writer, in this article, describes the difficulty met with in measuring the horsepower delivered by the steam turbine. The approved method of gaging the power delivered by reciprocating engines is by computing it from indicator cards. This is manifestly impossible with the turbine. In small machines the power may be absorbed by the prony brake or some equivalent mechanism, and thus weighed; in direct-connected electrical units the power output may be calculated from the readings of the voltmeters and ammeters. In larger machines, however, and particularly in the case of the marine turbine, none of these plans work. The engineers connected with the writer's firm finally hit upon the plan of using the angular flexure of the shaft, as measured between



Torsiometer Applied to the Measurement of Turbine Power.

two definite points in its length, as a measure of the torque transmitted. Knowing the torque and the revolutions per minute, the horsepower could be obtained directly.

The cut above shows the first practical solution. Two gun-metal wheels *A* and *B* were fastened to the shaft at a definite and known distance apart, the distance being as great as possible. On each wheel a permanent magnet, with a sharp chisel-shaped edge, was fixed radially at the periphery of the wheel, and with the sharp edge parallel to the shaft. At one end a soft iron electro-magnet *C* wound with fine wire, similarly chisel-shaped, was fixed, so that the moving magnet passed directly over the electro-magnet once in each revolution. At the other end a similar electro-magnet *D* was mounted on a threaded sector, and wires from these electro-magnets were led to a differentially-wound telephone receiver. If the shaft revolved without transmitting power, the permanent magnets passed these electro-magnets simultaneously, and currents of electricity generated in each coil passed through the telephone receiver, but the currents being equal and opposite no sound was heard. When the shaft transmitted power, the permanent magnets passed the electro-magnets at different times, and hence a sound was heard in the receiver. By turning the hand-wheel shown in the diagram, a new position of silence could be obtained, when it was evident that the two permanent magnets were again passing the electro-magnets simultaneously, and the amount of torque could be ascertained from the reading of the sector screw.

A later development of this idea was devised which allowed the measurements to be taken in a quiet cabin in any part of the ship instead of necessitating the operator's presence in the more or less noisy tunnel shaft, where there was some possibility of error in interpreting the sounds in the telephone receiver. This method retains the chisel-shaped magnets, but replaces the electro-magnets with a pair of specially wound "inductors" under each wheel, these inductors being so arranged as to permit different portions of their arcs to be active, giving thus the equivalent of shifting the electro-magnet *D* by the hand-wheel. This shifting of the active portion of the inductor is done by switches in the operating room, and does not require the presence of the operator in the tunnel.

The original solution of the problem, earlier than that shown in the cut, was by the obvious method of using on the disks contact points, which struck a fixed point in place of electro-magnet *C*, and an adjustable magnet point in place of electro-magnet *D*. As each contact came around, the circuit was closed, and a sharp click was heard in the telephone receiver. When the hand-wheel was so adjusted that the clicks were simultaneous, the amount of distortion would be read from the graduated disk. While this worked very well on the factory line shaft where it was first tried, at a speed of about 120 revolutions per minute, it failed to be of any use in taking measurements on the side shafts of the "Queen Alexandra," where the speed was over 700 revolutions per minute. Under these circumstances no certain sound could be obtained. It was impossible to be quite sure of the exact point at which the make and break took place, so that the apparatus was useless.

The testing of the shaft to get the torsion scale, previous to its being fitted on board, is done by fixing rigidly one end of the length of the shaft to be used for the trials, and at the other end fitting a lever; this is loaded with weights so as to get the scale or torsion moment. For turbine shafts, which are small in diameter as a rule, this is not a serious operation; nor, indeed, have we found it so even for larger ordinary twin-screw shafts, although, of course, the weights used have to be much greater. We have tested all the shafts for the turbines and other vessels on which we have used these instruments, and we find that the torsion is given very closely by the following formula:

$$\theta^\circ = \frac{W R L}{K d^4}$$

where

θ° = angle of torsion in degrees.
$W R$ = foot-pounds turning moment.
L = length of shaft in feet.
d = diameter of shaft in inches.
K = coefficient.

K may be taken at 140 for mild steel shafts where there are no couplings, or, if there be any, by deducting their length from the length of shaft twisted; that is, we assume that the couplings do not twist. It is, of course, better to test each shaft independently, but the error would not be great by using the formula, probably not 1 per cent either way.

MATERIALS AND CONSTRUCTION OF PUMPS FOR USE WITH VARIOUS LIQUIDS.

B. Björling, *Engineering Review*, April, 1907.

When purchasing a pump there are many things that must be considered, as, for instance, the quantity of liquid to be pumped, its nature and chemical properties, and whether the liquid is clean or contaminated with sand, mud, or any other impurities of this class that will wear a pump piston or plunger very quickly. For these reasons, to decide what class of pump and of what material the pump should be made, also what class of valves and what material they should be made of, are the most important considerations.

Materials and Design of Pumps for Various Liquids.

Tar and Ammoniacal Liquor.—All parts coming in contact with the liquid must be of cast iron.

Sewage.—Cast iron as a rule should be exclusively used.

Vinegar.—Gun metal or phosphor bronze should be used. If the vinegar is extra strong, antimony should be used as an alloy with lead.

Acids.—For strong acids, single acting plunger pumps made of earthenware, stoneware, glass, gutta-percha, or cast iron

lined with gutta-percha are necessary. For these pumps, all the packing in boxes and gaskets should be made with asbestos. A good construction is to make the barrels of the best glass, bored and polished true and parallel. The top and bottom chamber are made of lead or an alloy of lead and antimony. This construction is advisable also for alkaline fluids. Double acting air pumps operating by displacement may also be used.

Beer.—Bucket pumps or wing pumps made of gun metal may be used.

Benzine, Benzole and Creosote.—Double-acting piston pumps of cast iron may be used, with working barrels made of gun metal for small pumps, and cast iron lined with gun metal for large pumps, the pump rods to be of Delta metal.

Bleaching Liquids.—Use triple barrel bucket pumps of cast iron, with gun-metal lined bearings.

Dyes.—Double-acting piston pumps of materials depending on the chemical properties of dye to be pumped.

Milk of Lime.—Pumps of any type made entirely of gun-metal.

Naphtha.—Pumps of any type made of cast iron throughout.

Vegetable Oils.—Gun metal should be used.

Petroleum and Similar Mineral Oils.—Cast iron must be used.

Salt Water.—Any type of pump, but all parts must be made of gun-metal. A good alloy is as follows: copper, 8 parts; tin, 10 parts; zinc, 2 parts.

Sugar Solution and Treacle.—Use double-acting piston pumps or single, double or triple barrel plunger pumps, all parts being made of gun metal. Semi-rotary or wing pumps may also be used.

Wine.—Same as for sugar.

Hydrochloric Acids.—Parts must be made of Hargreave and Robinson's patent white metal, or the following alloy: lead, 1 pound; tin, 1 ounce; antimony, 1 ounce. These three metals must be quickly and intimately mixed just before casting.

Materials and Design of Valves for Pumps Handling Various Liquids.

Ammoniacal Liquor.—Valves should be of the miter type, made of cast iron, or mechanically moved piston valves; slide valves may be used, but they are not as good.

Anthracite Oil.—Same as for ammoniacal liquor.

Benzine, Benzole and Bilge Water.—Miter valves of gun-metal. If the height of lift is small, gun-metal balls may be used.

Beer and General Brewery Use.—Any type of valve will do, though clack valves are sluggish in their actions, allowing considerable slip. The valves should be made of gun-metal.

Creosote.—Cast malleable clack or miter valves should be used.

Gelatinous Fluids.—If not containing acids, gun-metal clack valves should be used. If acid is present, a large proportion of lead should be used in the gun-metal alloy.

Glutinous Fluids.—If of thick consistency, mechanically moved piston valves, cast iron clack valves, or ball valves will answer nicely. If the fluid is thin, cast malleable miter valves may be used.

Hot Water.—Gun metal valves of the miter type are best.

Warm Water.—India rubber disk valves, specially prepared, or vulcanized fiber manufactured for the purpose.

Milk of Lime.—Gun-metal clack or ball valves.

Naphtha.—Cast iron or cast malleable iron miter valves; the latter are the best.

Vegetable Oil.—Gun-metal miter or clack valves.

Paper Pulp.—Cast iron ball valves are best and cheapest. India rubber has been recommended, but it is expensive and wears out quickly.

Treacle and Sugar Solution.—Clack valves or mechanically moved piston valves of gun-metal.

Tan Liquor.—Gun-metal bell or clack valves. The alloy must possess a great proportion of lead to be immune from the tannic acid contained in the liquor.

Tar.—Pumps for this substance are best fitted with mechanically operated piston valves, or miter valves made of cast malleable iron.

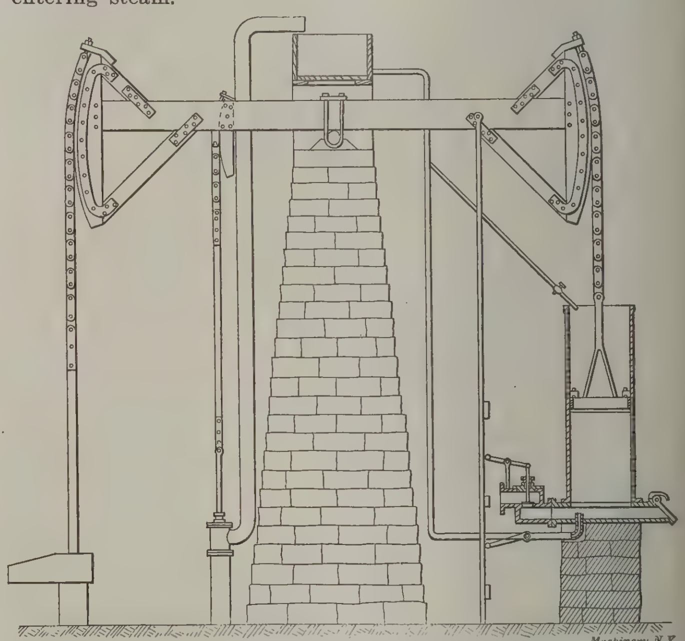
It is important to know that where the valve is of metal, both the surfaces in contact on the valve and seat must be made of the same material, whether it is a pure metal or an alloy, otherwise an electrolytic action will take place which will eat away the metal. Miter valves and others with perpendicular lift should have all the ribs and guides placed at an incline from the perpendicular, so that water in passing through will give the valve a gradual circular motion, tending to keep the beat perfect and prevent the formation of grooves. An inclination of ½ inch in 6 inches is enough for small valves, increasing to 2½ inches per foot for the largest sizes.

THE DIARY OF A MACHINIST IN 1760.

Alonzo G. Collins in *Power*, April, 1907.

After describing a holiday jaunt of a party of engineers through the old coal and iron districts of England in search of samples of the engineering works of Newcomen or Watt, the writer tells of the finding of an old atmospheric engine in a rough, thicket-grown field on property belonging to the Earl of Stamford and Warrington. A sketch of the engine is shown below.

The cylinder is of cast-iron, twenty-seven inches in diameter, and about six feet stroke. Steam entered at the bottom of the cylinder, and after the induction valve had been closed the steam in the cylinder was condensed by a jet of water injected into it, thus forming a vacuum under the piston, when the atmospheric pressure on the top of the piston forced it down; on the induction valve being again opened, the condensed steam and injection water were blown out by the entering steam.



Old Atmospheric Engine from 1760.

It must be understood that the pump end of the lever, due to the weight of the pump-rod, is heavier than the steam end. This is made purposely so, as owing to the flexible connection, the steam pressure cannot raise the steam end of the beam, the only purpose of the steam being to assist, by its condensation, in forming a vacuum under the piston. All of the work is done by the pressure of the atmosphere on the upper face of the piston, and as one or two pounds of steam pressure was ample for this purpose, and was as much as was usually carried, the excessive lead given the steam valve by the valve gear shown was not detrimental. On the upstroke of the piston it was absolutely necessary to permit the vacuum to be formed before the piston reached its upper limit of travel. This was in order to overcome the momentum of the heavy pump-rods in their descent and bring them to rest before the beam should strike the stops.

Mr. Reynolds tried to imagine how those early engineers contrived to do their work with tools and facilities that must have been crude in the extreme. He determined to prolong his vacation and make a tour of investigation. At Coalbrookdale in Shropshire, it was said a number of Newcomen pumping engines had been built at the iron works owned by the Brothers Darby. He had very little difficulty in locating the

successors of the old Darby works, and was highly pleased to find that his ancestor, Richard Reynolds, had been a manager of the old works at about 1760. This at once gave him a standing with the proprietors, who gave him the privilege of searching through a mass of old records and drawings. He was rewarded by finding a journal of one of the old-time workmen, who had spent his spare time setting down his experiences. The introductory pages of the diary were missing. The first whole entry was an account of the making of a steam cylinder, as follows:

"Began this day to scour the bore of a great cylinder of a fire engine for drawing the water from the coal pit at Elphinstone, of a bore twenty-eight inches across, and in length nine feet, the same being cast of brass after much discouragement, and the spoiling of three before, which made us of much doubt if we could ever succeed in a task of such great magnitude; but being, by reason of the extremity to which the proprietors of the pit were at, having to employ more than fifty horses to discharge the water thereof, much urged to persevere, we give great gratitude to Almighty God, who hath brought us through such fiery tribulations to an efficient termination of our arduous labors.

"Having hewed two balks of deal to a suitable shape for the cylinder to lie therein solidly on the earth in the yard, a plumber was procured to cast a lump of lead of about three hundred weight, which being cast in the cylinder, with a dike of plank and putty either side, did make it of a curve to suit the circumference, by which the scouring was much expedited.

"I then fashioned two iron bars to go around the lead, whereby ropes might be tied, by which the lead might be pulled to and fro by six sturdy and nimble men harnessed to each rope, and by smearing the cylinder with emery and train oil through which the lead was pulled, the circumference of the cylinder on which the lead lay was presently made of a superior smoothness; after which the cylinder being turned a little, and that part made smooth, and so on, until with exquisite pains and much labor the whole circumference was scoured to such a degree of roundness, as to make the longest way across less than the thickness of my little finger greater than the shortest way; which was a matter of much pleasure to me, as being the best that we so far had any knowledge of; but I was busy casting about in my mind for means as to how it might be in future made better, and I reckoned, for one thing, that I would so fashion the iron bars to which the ropes were tied, that they might be laid in the cylinder, and the lead cast on them, and so fasten them firmly."

The greater part of the writing for the next few pages was so faded as to be undecipherable, but it seemed to refer to the construction and fitting of the minor parts of the engine. Further on was the following account of the erection of the engine at the mine:

"The carriage of the engine to the coal pit was a most difficult matter; the wagon on which was the cylinder, being of insufficient strength, was often broken, and in the low places of the road we had often to put twelve sturdy horses to it, but by perseverance and our great ambition it was at last at the end of our journey with no serious mishap.

"We had at first been at some discouragement about the pumps, as we had a very imperfect notion of them; but, succeeding in having the assistance of several admirable and ingenious workmen of Birmingham, we came to the method of making the pump, valves, clacks and buckets in a very superior manner; and they being now arrived, I put some of the workmen to set them in their place in the pit, fashioning strong timbers at the mouth of the pit, and otherwheres, as I judged might be wanted for the proper supporting of it, with the mouth of the pump so high from the ground that the water might find its way to get clear of the pit.

"The great pillar I made eighteen feet long in a direction crosswise of the great lever, and nine feet the other way, at the bottom, inclining the sides, so that it should be four feet square at the top and twenty-six feet tall from the ground; it was built in the firmest manner and solid, course by course, with thin lime mortar, of lime that had not been too long slaked; at the top I set stout iron bars, the stones set around them, with screws on the end, by which to fix the gudgeon blocks solidly. On the other side of the pillar from the pump I set off to each side, lengthwise of the great lever, two stout stone walls on which to build the cylinder beams.

"It had formerly been the custom to place the cylinder over above the boiler; but this had been so troublesome by account of the great straining and jumping of the cylinder, by the great force of the steam, causing the divers joints to leak, and spoiling the stone walls of the furnace, although built ever so solidly, that I made shift to place the boiler a little distance away and to convey the steam to the cylinder by a copper pipe, which by reason of its elasticity would jump with the cylinder and thus, I reckoned, would not so soon spoil the joints.

"I then set the plumbers and coppersmiths to fashion the boiler, with great sheets of copper for the bottom, where the fire was, and similar sheets of lead for the top, which, being preserved from the fire, would not so readily be spoiled.

"The sheets of copper were set with the border of one sheet over the border of another, with hacks or cogs so cut in them as to lock one with the other, and soldered with spelter, like coppers for brewing, until there was one monstrous sheet, which the workmen reckoned large enough for our needs. They then with huge hammers and a mighty din so contrived their blows as to bend the copper to a half circle, like unto half of a globe, with the border turned out to shape a flanch, to which the lead, being similarly shaped, was made firmly solid, with putty between to stop the steam and bars of iron above and below, by screw-bolts. It was a task of greater magnitude than any we had yet undertaken, but with rare skill the ingenious workmen found means for overcoming our difficulties in a most admirable manner.

"Before the boiler could be set in its place it was needful that the cylinder should be got to its place, as otherwise there would be no room for it to pass. This task I desired to take in hand myself, as the other workmen were timorous about how it was to be got up, and a stout heart as well as a nimble body were needed if we were to have no mishaps. So a skilled woodsman fashioned as I directed some round logs of wood, truly round and straight, and others fashioned a sort of frame or cradle of massive timbers in which the cylinder might lie at ease, and the round logs on the ground beneath all, so that it was as if the cylinder was on a wagon, but low down, so that there was but small risk of its overturning; and so, with many sturdy men pulling at ropes in front and others with stout pries pushing from behind, it was at last got between the stone walls on which it was to rest.

"I now must set it on its bottom, upright, which I accomplished by lifting the top end with pries as far as the purchase might go, and, with strong timbers under it, hold it so until a new purchase could be had for the pries, and so on, until it was almost upright, when I fixed ropes to the top whereby some stout men could hold back and thus deter it from overbalancing from its momentum when it came upright, which it came near doing, as the men were caught unawares and were fair dragged some distance; but a shout from me put them on their mettle, and it got no further.

"It was now to be lifted about six feet, to get it to where the flanches on each side could sit on the cylinder beams, and this seemed the most perilous task of all, as it stood so tall and slender, as though a strong wind would suffice to overturn it. I contrived to do it, however, by means of two pries on opposite sides of the cylinder, under the bottom flanch, and four ropes from the top, with some sturdy men to pull four ways to keep it upright, whereby lifting on the pries steadily and sedately, as far as the purchase would go, and by building up with planks laid evenly under the flanch, between the inner ends of the pries, the cylinder was held up until a new purchase was made for the pries, and so on; and I was much pleased to have it go so smoothly.

"It was fairly the easiest part of it, and it was done so much speedier than I deemed possible, that I was constrained to let the men lie by for the rest of the day, as a token of good will for their nimbleness.

"The joint between the cylinder and the bottom I made firm with lead, beaten thin where the space was slim, so to match the unevenness of the flanches, and after the bolts were screwed firm, by beating the flanches with hammers and warming with a small fire, to soften the lead, I at last got it so that it was stanch with the cylinder filled with water; the other joints in the pipes, and so forth, I made firm with putty."

After describing the making of the walking beam and its gudgeon, he says:

"I now perceived where I had been at fault through my ignorance, in that I had supplied no place for the cistern for the cooling water, which must be on a tall place to cause the water to enter the water case speedily; but I contrived some timbers above the great lever, on the top of the great pillar, which did answer very well, but I had a very imperfect knowledge as to how I should get the water to it, and cast about to find some brook to back up by a dam, but found nothing to my liking, until one of the workmen contrived a little pump with clacks and bucket, which should derive its water from the top of the great pump.

"I fashioned a small curve on the side of the great lever, half-way between the end and the middle, whereby with chain and pump-rod to give motion to it, and a lead pipe to convey the water to the cistern, also a lead pipe from the bottom of the cistern to the water case, and a branch pipe to discharge water on top of the piston to stop air from going in the cylinder, with a cock in each to regulate the water."

* * *

According to a statement made by the *Mining Reporter* the cost of assembling all the raw material for making iron at Birmingham, Ala., is 77 cents per ton, which is the lowest figure ever reached either in this country or abroad.

ON THE ART OF CUTTING METALS.—6.*

FRED W. TAYLOR.

PRESSURE OF THE CHIP ON THE TOOL.

In 1883 in the works of Wm. Sellers & Co., of Philadelphia, a series of experiments was made by Messrs. Wilfred Lewis and John Bancroft with a dynamometer, in which the pressure of the chip upon the lip surface of the tool was measured. These experiments showed that for steels varying greatly in hardness, and consequently in their cutting speeds, the variation in the pressure of the chip upon the tool in no way corresponded either to the hardness of the steel or to the speed at which it could be cut. A further study of the results of these experiments indicated also that there was no clearly defined and traceable relation between the tensile strength or the crushing strength of steel and the cutting speed. These results agreed accurately with the observations which we had made in our many experiments on cutting speeds, namely, that lathes, boring mills, etc., are able to pull about as heavy cuts with hard as with the soft steels, although there is a very great difference between the cutting speeds of hard and soft steels. Having established this important fact to our satisfaction, and having through these experiments obtained sufficient data for properly designing machine tools as to the power required to cut metals, no further experiments were made by us in this line until the year 1902, when the subject was again more carefully investigated through dynamometer experiments in the shop of Wm. Sellers & Co.

The results of our experiments show that no law can be established or formulated for cutting steel which expresses either (*a*) the relation between cutting speed and the pressure on the tool; or (*b*) the relation between cutting speed and the tensile and crushing strength of the metal to be cut.

Relation between Tool Pressure and Cutting Speed, Etc.

Although the tensile strength of soft steels is much lower than that of hard steels, yet in many cases it requires more foot-pounds of energy to break, by pulling apart in a testing machine, a test bar of low tensile strength, than one of high tensile strength. The reason for this is that the percentage of stretch or extension in the soft steel bar is in most cases much greater than that in the hard steel. When we consider the fact that throughout the time that a test bar is stretching, all of the grains inside of the bar are continually flowing, moving, or sliding past one another under what may be called very heavy internal friction, it becomes clear that in spite of the fact that the pull or power required to cause flow in the grains or crystals of the soft steel is less than the pull required to move the grains of a hard steel bar, yet the greater distance through which the grains of the soft steel continue to flow more than makes up for the difference of tensile strength in the final sum total of energy expended.

In tearing a chip from a bar of steel, the grains or molecules of the metal of the chip are caused to flow past one another under very severe compression for a considerable distance, so that the thickness of the layer of metal being removed is double in the chip what it was originally in the forging. In the case of a chip torn from soft metal, the movement or flow of the grains of the chip past one another is much greater than in the case of a hard chip. In other words, a soft steel chip is thickened up in cutting much more than a hard steel chip.

Thus, in cutting a chip, the total energy expended and the pressure of the chip on the tool are in many cases greater with a soft steel than with a hard steel. In cutting soft steel, owing to the fact that it thickens more than the hard steel, the chip bears upon the lip surface of the tool over a much larger area than in cutting hard steel, and although undoubtedly the intensity of the pressure on any one small spot on the lip surface of the tool is greater in cutting hard steel than in cutting soft steel, yet the larger area which is under pressure with the soft steel chip more than makes up in many cases for the difference in the intensity. Therefore, frequently a heavier total pressure is produced with the soft steel than with the hard.

The pressure of the chip on the tool is doubtless greater, the finer the quality of the metal which is being cut, *i.e.*, in metals which combine both a high tensile strength and a comparatively large percentage of stretch; such, for instance, as the fine qualities of low phosphorous steels which have been most carefully worked in forging, or the thoroughly oil-tempered and annealed gun forgings, or high grades of tool steel, in all of which exceedingly high combinations of tensile strength and stretch are attained. And again, it should be noted that although the pressures on the tool are high in these fine qualities of steel, yet the cutting speeds are by no means proportionally slow. The slowest speeds are to be found in cutting chilled iron or more or less hardened steels, which generally have an exceedingly low percentage of stretch and also comparatively low pressures on the tool.

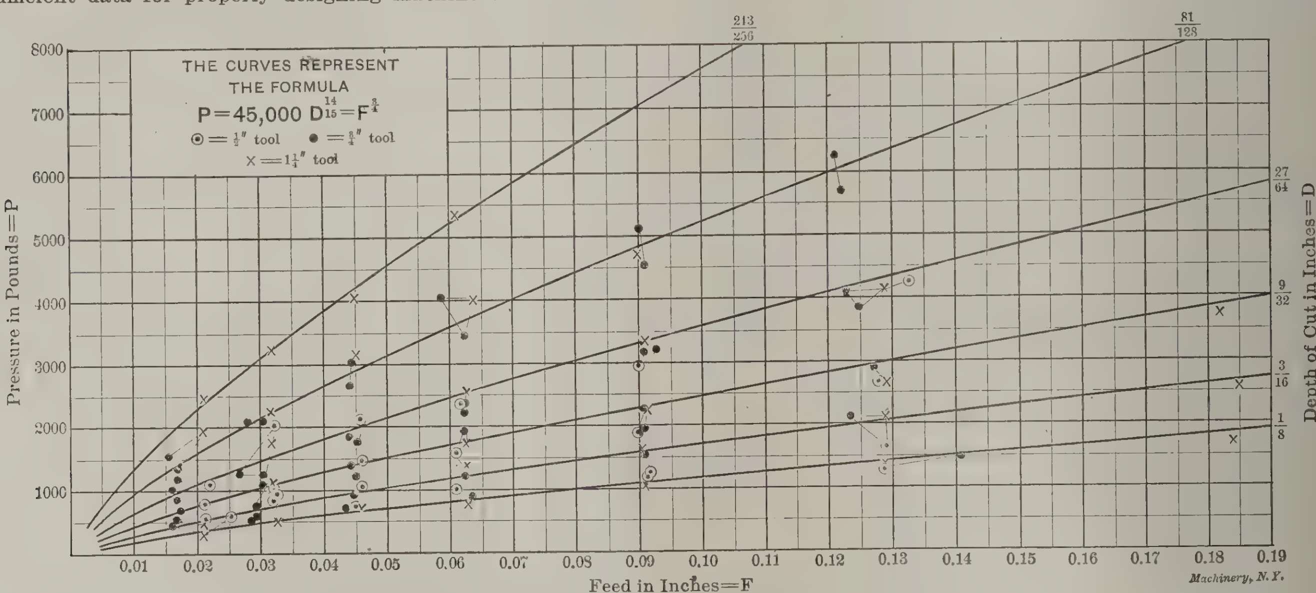


Fig. 45. Diagram showing Pressure on Tool with 1-2, 3-4 and 1 1-4 inch Tools Cutting Cast Iron.

Kind of Metal.	Carbon, per cent.	Tensile Strength in tons (2000 lbs.)	Percentage of Stretch.	Pressure of Chip on Tool in tons (2000 lbs.)	Cutting Speed in feet per minute.
Steel forging.......	0.50	52	14	168	41
Steel roll...........	0.55	51	8	128	35
Steel car wheel casting.......	0.82	48	3	92	22

An illustration of this will be seen in the table above, furnishing a comparison of three pieces of metal. In the first line will be found a forging consisting of a good quality of hard steel, and in the second and third lines a steel roll and a car wheel casting.

The percentage of carbon of this forging and roll are about

* Abstract of paper presented before the American Society of Mechanical Engineers, December, 1906.

the same, and the tensile strengths of all three are also about the same. On the other hand, the stretch of the roll is only a little more than one-half that of the forging, showing an inferior quality of metal. The casting has a still lower stretch, and is of still lower quality, because it has not received work under the hammer. And this falling off in the quality of the metal indicated by low stretch is also accompanied by a falling off in the pressure of the chip upon the tool, the casting having only 92 tons, the roll having only 128 tons, while the forging has 168 tons pressure. Thus we see that an inferior quality of metal is accompanied by a lower pressure upon the tool. If the metal in the casting had been forged, its tensile strength would probably have not greatly increased, but it would without doubt have had a very materially higher percentage of stretch, and the pressure on the tool would have increased accordingly.

The car wheel casting, which gives a pressure on the tool of only 92 tons per square inch sectional area of the shaving, percentage of stretch in hard steels, *i.e.*, a smaller capacity for flow.

Pressure of the Chip on the Tool in Cutting Cast Iron.

A. The total pressure of chip on tool in cutting cast iron of the different qualities experimented upon by us varies between the low limit of 35 tons (2,000 pounds) per square inch sectional area of chip for soft cast iron, when a coarse feed is used, and 99 tons per square inch sectional area of chip for hard cast iron, when a fine feed is used.

B. In cutting the same piece of cast iron, the pressure of chip on the tool per square inch sectional area of chip grows considerably greater as the chip becomes thinner, and slightly greater as the cut becomes more shallow in depth. The following are the high and low limits of pressure per square inch of sectional area of the chip when light and heavy cuts are taken on the same piece of cast iron.

Depth of cut, ⅛ inch, × feed, 0.0328 inch. = Total pressure per sq. in. sectional area of chip, 128,000 lbs.

Depth of cut, $\frac{27}{64}$ inch, × feed, 0.1292 inch = Total pressure per sq. in. sectional area of chip, 75,000 lbs.

TABLE I. PRESSURES OF THE CHIP ON THE TOOL IN CUTTING CAST IRON WITH STANDARD TOOLS, CLEARANCE ANGLE 6 DEGREES, BACK SLOPE 8 DEGREES, SIDE SLOPE 14 DEGREES.

	SOFT CAST IRON. Tensile Strength, 12400. Chemical Composition: Combined Carbon, Graphite, Manganese, Silicon, 1.7 per cent, Phosphorus, Sulphur												HARD CAST IRON. Tensile Strength ..... 24000; Silicon ..... 1.2 per cent. (Formula $69,000\ D^{\frac{14}{15}} F^{\frac{3}{4}}$)				Pressure in pounds in cutting soft cast iron figured by formula $45,000\ D^{\frac{14}{15}} F^{\frac{3}{4}}$. Compare these pressures with the experimental pressures in the first columns of this table			
	½" TOOL				¾" TOOL				1¼" TOOL				1" TOOL							
			Pressure in pounds				Pressure in pounds				Pressure in pounds				Pressure in pounds		Feed in		Pressure in pounds	
Depth of cut in inches	Experiment number	Feed in inches	On tool	Per sq. in.	Experiment number	Feed in inches	On tool	Per sq. in.	Experiment number	Feed in inches	On tool	Per sq. in.	Experiment number	Feed in inches	On tool	Per sq. in.	Fractions	Decimals	On tool	Per sq. in.
⅛	930	0.0252	592	188000	483	0.0164	475	232000	954	0.0212	337	127000					1/64	0.01562	289	146206
	931	0.0320	854	213000	484	0.0286	552	154000	955	0.0328	526	128000					1/32	0.03125	480	122899
	932	0.0452	723	128000	485	0.0440	721	141000	956	0.0460	772	134000					3/64	0.04687	651	111092
	933	0.0608	970	127000	486	0.0635	905	114000	957	0.0628	805	102000	1153	0.0640	1430	178000	1/16	0.06250	808	103383
	934	0.0916	1167	102000	487	0.0900	1115	99000	958	0.0908	1019	90000	1154	0.0928	1820	157000	3/32	0 09375	1168	93419
	935	0.1288	1266	79000	488	0 1403	1490	88000	959	0.1292	1315	81000	1155	0.1300	2325	135000	⅛	0.12500	1358	86930
									960	0.1840	1740	77000	1156	0.1850	3166	140000	3/16	0.18750	1764	78604
3/16	936	0.0212	576	145000	489	0.0168	581	184000	961	0.0212	525	132000					1/64	0.01562	417	142379
	937	0 0324	914	150000	490	0.0292	581	106000	962	0.0320	881	147000					1/32	0.03125	701	119683
	938	0 0460	1016	118000	491	0.0446	888	106000	963	0 0460	1000	114000	1157	0.0460	1220	141000	3/64	0.04687	951	108184
	939	0.0612	983	86000	492	0.0625	1195	102000	964	0.0628	1355	115000	1158	0.0648	1775	145000	1/16	0.06250	1180	100677
	940	0.0920	1202	69000	493	0.0900	1533	90000	965	0.0908	1643	96000	1159	0.0928	2360	135000	3/32	0.09375	1599	90974
	941	0 1292	1642	67000	494	0.1234	2100	93000	966	0.1292	2115	90000	1160	0.1300	2860	117000	⅛	0.12500	1984	84648
									967	0.1848	2618	75000	1161	0.1815	4070	119000	3/16	0.18750	2690	76503
9/32	942	0.0212	793	132000	512	0 0174	684	139000	968	0 0212	751	126000					1/64	0.01562	609	138511
	943	0.0320	1008	112000	511	0 0294	735	88000	969	0 0320	1135	126000	1162	0.0324	1545	169000	1/32	0.03125	1024	116474
	944	0 0460	1405	108000	510	0 0452	1163	91000	970	0.0460	1467	113000	1163	0.0460	1925	148000	3/64	0.04687	1364	105266
	945	0 0612	1570	93000	509	0.0625	1317	74000	971	0.0628	1785	92000	1164	0.0608	2478	144000	1/16	0.06250	1722	97942
	946	0 0900	1883	74000	508	0 0909	1949	76000	972	0.0912	2205	86000	1165	0.0908	3440	134000	3/32	0.09375	2334	88502
	947	0.1280	2628	72000	507	0 1282	2600	72000	973	0.1292	2670	82000	1166	0.1250	4485	127000	⅛	0.12500	2893	82294
									974	0.1828	3810	74000	1167	0.1800	5570	110000	3/16	0.18750	3933	74474
27/64	948	0 0220	1088	117000	501	0 0162	998	146000	975	0 0212	1052	114000	1168	0 0204	986	114000	1/64	0.01562	889	134817
	949	0 0324	2012	149000	502	0 0264	1260	113000	976	0.0320	1757	120000	1169	0.0320	2250	166000	1/32	0.03125	1495	113368
	950	0 0460	2068	107000	503	0.0452	1770	92000	977	0 0460	2088	107000	1170	0 0460	2880	148000	3/64	0.04687	2026	102439
	951	0.0620	2321	88000	504	0 0625	2345	88000	978	0.0628	2568	91000	1171	0.0608	3740	145000	1/16	0.06250	2514	95330
	952	0 0900	2940	77000	505	0 0926	3200	82000	979	0 0912	3373	87000	1172	0.0912	4960	128000	3/32	0.09375	3453	86143
	953	0 1327	4240	73000	506	0.1250	3830	72000	980	0.1292	4108	75000	1173	0.1288	6850	126000	⅛	0.12500	4227	80158
81/128					500	0 0156	1556	157000	981	0.0212	1984	142000	1174	0.0200	2688	212000	1/64	0.01562	1297	131222
					499	0.0280	2090	117000	982	0.0320	2245	111000	1175	0.0312	3490	177000	1/32	0.03125	2183	110344
					498	0.0446	3020	107000	983	0 0452	3164	110000	1176	0.0460	4865	167000	3/64	0.04687	2958	99707
					496	0.0588	4040	109000	984	0 0640	4022	99000	1177	0.0608	5660	145000	1/16	0.06250	3670	92788
					497	0.0901	5095	89000	985	0 0900	4744	83000	1178	0.0900	6960	122000	3/32	0.09375	4974	83845
					495	0 1212	6240	81000									⅛	0.12500	6172	78025
243/256									986	0 0212	2482	123000					1/64	0.01562	1594	127722
									987	0.0320	3260	107000					1/32	0.03125	3189	107437
									988	0 0452	4140	96000					3/64	0 04687	4437	97052
									989	0 0612	5370	92000					1/16	0.06250	5358	90313

has a slower cutting speed than any of the other samples of steel which were cut, and yet it has the lowest total pressure on the tool of any steel. This is an excellent illustration of the fact that the hardness in steel which causes a low cutting speed is not accompanied by the highest pressures on the tool. On the other hand, this steel casting has only 3 per cent of stretch and it is undoubtedly this low percentage of stretch which accounts for the slow cutting speed.

To summarize: (*a*) In cutting hard metals, the intensity of the pressure per square inch of the lip surface of the tool which comes in contact with the shaving is much greater than in cutting soft metals; (*b*) the center of pressure is much closer to the cutting edge; and (*c*) the section of metal directly below the center of pressure is smaller for carrying the heat away.

All of these conditions which tend greatly toward lowering the cutting speed are brought about not so much through the greater crushing strength of hard steels as through the smaller

C. The same fact mathematically expressed is that in cutting the same piece of cast iron, the pressure of chip on the tool per square inch sectional area of chip grows greater as the thickness of the chip grows less in proportion to (thickness of the feed)$^{\frac{1}{4}}$ or $F^{\frac{1}{4}}$.

The pressure of chip per square inch of section also grows greater as the depth of the cut grows less in proportion to (depth cut)$^{\frac{1}{15}}$ or $D^{\frac{1}{15}}$.

D. The effect upon the pressure of the chip on the tool of a change in the thickness of the feed and the depth of the cut is the same for hard and soft cast iron, and is represented by the same general formula, with a change merely of the constant.

E. In taking cuts having the same depth and the same feed, the pressure of the chip on the tool becomes slightly greater, the larger the cutting tool that is used. This increase in the pressure follows from the fact that the larger the curve of the cutting edge of the tool, the thinner the shaving becomes.

Objects of Experiments on Pressure.

The principal object in making the experiments described in detail below was to determine, broadly speaking, the maxi-

mum pressures upon the tool per square inch of sectional area of the chip, both in cutting soft and hard cast iron, when our standard shop tools of different sizes were used, this information being needed in designing machine tools; for this purpose the highest pressure of 99 tons (2,000 pounds) as indicated in Table I., should be sufficient.

Our secondary object, and one of almost equal importance, was that of obtaining the pressure on tool per square inch of sectional area of the chip being cut, corresponding to various changes in the depth of cut and in the thickness of the feed. This information is needed in determining by means of our slide rules the exact sized cut which each machine tool is capable of taking under its possible combinations of pulling power, speed and changes in the thickness of feed.

In Table I. will be seen a summary of the actual pressures obtained under various conditions in these experiments, and in adjoining columns the pressures are reduced to pounds per square inch of sectional area of chip. The same data for ½, ¾ and 1¼-inch tools are reported in the diagram, Fig. 45.

On the left-hand side of this diagram is recorded the regularly increasing pressures per square inch of sectional area of the chip upon the tool; while on the bottom line are recorded the regular increases in the thickness of the feed.

In a series of heavy lines on the diagram are drawn curves corresponding to the following formula, which expresses the general relation existing between the depth of cut and the feed, and the pressure on the tool for all of the grades of cast iron experimented upon:

$$P = C\, D^{\frac{14}{15}}\, F^{\frac{3}{4}}$$

in which

P = the pressure on the tool;

D = depth of cut in inches;

F = feed in inches;

C = a constant depending upon the softness or hardness of the cast iron, and which varies between the limits of 45,000 for soft and 69,000 for hard cast iron, as experimented on by us.

Pressure of the Chip on the Tool in Cutting Steel.

The following are the general conclusions arrived at on this subject:

A. The total pressure of the chip on the tool in cutting steel of the different qualities experimented upon by us varies between the low limit of 92 tons (2,000 pounds) per square inch of sectional area of the chip, and the high limit of 168 tons per square inch sectional area of the chip.

B. In cutting the same piece of steel, the pressure of the chip on the tool per square inch of sectional area of the chip grows very slightly greater as the chip becomes thinner, and is practically the same whether the cut is deep or shallow; see Table II., from which are taken the following typical cases illustrating the relative pressures of a thin feed on the one hand and a coarse feed on the other.

Depth of cut, $\frac{3}{16}$ inch, × feed, 0.0156 inch = Total pressure per sq. in. sectional area of chip, 295,000 lbs.

Depth of cut, $\frac{3}{16}$ inch, × feed, 0.125 inch = Total pressure per sq. in. sectional area of chip, 257,000 lbs.

C. The same fact mathematically expressed is that in cutting the same piece of steel, the pressure of the chip on the tool per square inch of sectional area of the chip grows greater as the thickness of the chip grows less in proportion to (thickness of the feed)$^{\frac{1}{15}}$ or $F^{\frac{1}{15}}$.

The pressure of the chip is in direct proportion to the depth of the cut.

D. Within the limits of cutting speed in common use, the pressure of the chip upon the tool is the same whether fast or slow cutting speeds are used.

E. The pressure of the chip upon the tool depends but little upon the hardness or softness of the steel being cut, but increases as the quality of the steel grows finer. In other words, high grades of steel, whether soft or hard, give greater pressures on the tool than are given by inferior qualities of steel.

F. The pressure of the chip on the tool per square inch of sectional area of the chip depends both upon the tensile strength of the steel and its percentage of stretch, and increases both as the tensile strength and stretch increase; although a higher tensile strength has more effect than a large percentage of stretch in increasing the pressure.

TABLE II. PRESSURES OF THE CHIP ON THE TOOL IN CUTTING STEEL WITH STANDARD TOOLS, CLEARANCE ANGLE 6 DEGREES, BACK SLOPE 8 DEGREES, SIDE SLOPE 14 DEGREES.

	½" TOOL, CUTTING SPEED ABOUT 60 PER MINUTE				¾" TOOL, CUTTING SPEED ABOUT 30' PER MINUTE				¾" TOOL, CUTTING SPEED ABOUT 60' PER MINUTE				1¼" TOOL, CUTTING SPEED ABOUT 30' PER MINUTE				PRESSURE IN POUNDS, FIGURED BY FORMULA—230,000 $DF^{\frac{14}{15}}$ COMPARE THESE PRESSURES WITH THE EXPERIMENTAL PRESSURES IN THE OTHER FOUR COLUMNS OF THIS TABLE			
DEPTH OF CUT IN INCHES	EXPERIMENT NUMBER	FEED IN INCHES	PRESSURE IN POUNDS ON TOOL	PRESSURE IN POUNDS PER SQ. IN.	EXPERIMENT NUMBER	FEED IN INCHES	PRESSURE IN POUNDS ON TOOL	PRESSURE IN POUNDS PER SQ. IN.	EXPERIMENT NUMBER	FEED IN INCHES	PRESSURE IN POUNDS ON TOOL	PRESSURE IN POUNDS PER SQ. IN.	EXPERIMENT NUMBER	FEED IN INCHES	PRESSURE IN POUNDS ON TOOL	PRESSURE IN POUNDS PER SQ. IN.	FEED IN FRACTIONS	FEED IN DECIMALS	PRESSURE IN POUNDS ON TOOL	PRESSURE IN POUNDS PER SQ. IN.
1/8	565	0.0154	586	304000					435	0.0144	605	336000	541	0.0186	709	306000	1/64	0.01562	593	303550
	566	0.0305	1040	273000					434	0 0281	907	258000	542	0.0296	1124	304000	1/32	0.03125	1132	289842
	567	0 0422	1730	328000	535	0.0460	1537	267000	433	0 0428	1286	240000	543	0.0448	1615	288000	3/64	0.04687	1653	282054
	568	0.0625	2120	271000					432	0 0606	1928	254000	544	0.0608	1930	253000	1/16	0.06250	2162	276754
	569	0 0909	2850	250000	534	0.0909	3230	284000	431	0.0888	3175	286000	545	0.0930	3230	278000	3/32	0.09375	3156	269314
					534½	0 1282	4138	256000	430	0.1275	3855	242000	546	0.1250	4510	288000	1/8	0.12500	4129	264256
3/16	570	0 0166	993	319000					415	0.0115	736	341000	552	0.0156	865	295000	1/64	0.01562	889	303550
	571	0.0275	1400	271000	523	0.0314	1542	262000	414	0.0280	1345	256000	551	0.0300	1496	266000	1/32	0.03125	1698	289842
	572	0 0420	2690	341000					413	0.0414	2238	288000	550	0.0440	1986	241000	3/64	0.04687	2479	282054
	573	0.0625	3100	265000	520	0.0625	2721	232000	412	0.0625	3020	258000	549	0.0632	2760	237000	1/16	0.06250	3243	276754
					521	0 0885	4150	250000	416	0 0882	4884	295000	548	0.0909	4600	270000	3/32	0.09375	4734	269314
					522 539	0.0125	6620 5700	282000 243000	538	0.1250	5160	220000	547	0.1250	6000	257000	1/8	0.12500	6194	264256
9/32	574	0.0148	1300	342000					429	0.0140	1184	301000	553	0.0148	1230	296000	1/64	0.01562	1334	303550
	575	0.0275	2100	272000	530	0.0310	2230	255000	428	0.0287	2405	298000	554	0.0286	2135	265000	1/32	0 03125	2547	289842
					531	0.0452	3520	277000	427	0.0423	3320	278000	555	0.0403	2790	246000	3/64	0 04687	3718	282054
					532	0.0606	4430	239000	426	0.0620	4680	268000	556	0.0645	4630	255000	1/16	0.06250	4865	276754
					533	0 0909	7050	275000	425	0.0909	6708	262000	557	0.0909	6680	248000	3/32	0.09375	7101	269314
27/64	577	0.0148	2130	341000					424	0.0150	1932	305000	558	0.0174	2090	285000	1/64	0.01562	2001	303550
					529	0.0300	3680	290000	423	0.0298	3665	291000	559	0.0285	3360	279000	1/32	0.03125	3821	289842
					527	0.0448	5460	238000	422	0 0427	4930	273000	560	0.0405	4640	271000	3/64	0.04687	5578	282054
					528	0.0625	6920	262000	421	0.0552	6200	266000	561 576	0.0606	5760 6730	225000 263000	1/16	0.06250	7297	276754
81/128					525	0.0182	4270	371000					562	0.0154	2980	305000	1/64	0.01562	3001	303550
					524	0.0306	6140	317000					563	0.0282	5760	327000	1/32	0.03125	5732	289842
					526	0.0415	7815	297000	420	0.0424	7776	289000	564	0.0400	7700	304000	3/64	0.04687	8367	283054

Power Required to Feed the Tool.

By far the most important conclusion arrived at by us in the field of "Pressure of the Chip on the Tool" is that the gearing designed in lathes, boring mills, etc., for feeding the tool should be sufficiently strong to deliver at the nose of the tool *a feeding pressure equal to the entire driving pressure of the chip upon the lip surface of the tool.* This fact was developed by us in an experiment made in the year 1883 in the works of the Midvale Steel Company, and had such an important bearing upon the cost of turning out the product in the machine shop of those works that the results of this one simple investigation more than paid for all the experiments in the entire field of cutting metals undertaken in the Midvale Steel works.

All of the lathes, boring mills, etc., purchased by this company from that time forward were fitted with feed gearing designed with power equal to the driving power of the machine, and in this way the many stoppages and delays so common in the average machine shop, due to broken feed gearing, were avoided. What is of even much greater importance, a lack of strength in the feed gearing, never was accepted as an excuse on the part of any machinist for not taking the maximum cut on his machine. But in this respect this company stood alone for at least fifteen years.

BENDING STRESSES IN WIRE ROPE.

JAMES F. HOWE.*

James F. Howe.†

The study of different engineering problems brings out the proposition of two kinds of stresses, one seen and the other unseen. Those stresses which are caused by direct thrust or pull are easily seen and provided for, but the unknown forces, or the ones which fail to make an impression on our senses, are more difficult to grasp. Engineers have provided for such forces on some kinds of work by using a larger factor of safety. This method at best, however, only approximates, and should never be used except as a last resort, after all possible means for the determination of the stresses have been exhausted.

Wire rope, on account of its numerous applications to various engineering problems, such as derricks, traveling cranes, elevators, ore- and coal-handling machinery, etc., is becoming a vital adjunct to the solution of the problem of the economical handling of many different materials. The draftsman or designer of any apparatus requiring the use of wire rope has to decide upon the size of sheaves and drums which he will employ, and in a great many cases has only a vague idea of what size these should be made. To be sure, the catalogues of wire rope manufacturers give in a general way the smallest diameter of sheave or drum that should be used for any given size of rope, but it was never intended that sizes of sheave given as a minimum should be the only size to employ. Nevertheless, judged by this standard, a good many pieces of apparatus, of excellent design in other respects, show an almost total disregard for such recommendations, and the sheaves and drums used are of extremely small diameter. This is caused by a desire to make a compact apparatus, and to bring the first cost as low as possible, both of which are desirable features from a business standpoint. The purchaser of such an apparatus, however, is also interested in the cost of maintenance as well as in the first cost. He finds after a short period that his ropes have all gone to pieces, and procures another rope only to get the same result. In the design of his machine too small sheaves were used, and he finds it necessary to replace, at considerable expense, the small sheaves by larger ones, or to continue to have a high cost of maintenance.

TABLE I. TOTAL AREA IN SQUARE INCHES OF WIRES OF DIFFERENT ROPES.

Diameter of Rope.	6 x 7 Construction.	6 x 19 Construction.	6 x 37 Construction.	8 x 19 Construction
$2\frac{3}{4}$	......	2.6892	2.6704	......
$2\frac{1}{2}$	......	2.2224	2.2068	......
$2\frac{1}{4}$	......	1.8000	1.7876	......
2	......	1.4216	1.4124	......
$1\frac{3}{4}$	......	1.0888	1.0812	......
$1\frac{5}{8}$	..	0.9390	0.9324	......
$1\frac{1}{2}$	0.8334	0.7997	0.7929	0.6714
$1\frac{3}{8}$	0.7007	0.6723	0.6676	0.5643
$1\frac{1}{4}$	0.5791	0.5556	0.5517	0.4664
$1\frac{1}{8}$	0.4691	0.4500	0.4469	0.3778
1	0.3706	0.3554	0.3531	0.2985
$\frac{7}{8}$	0 2840	0.2722	0.2703	0.2285
$\frac{3}{4}$	0.2134	0.1999	0.1982	0.1678
$\frac{5}{8}$	0.1448	0.1389	0.1379	0.1166
$\frac{9}{16}$	0.1173	0.1125	0.1117	0.0945
$\frac{1}{2}$	0.0926	0.0889	0.0883	0.0746
$\frac{7}{16}$	0.0710	0.0681	0.0676	0.0571
$\frac{3}{8}$	0.0534	0.0500	0.0495	0.0419
$\frac{5}{16}$	0.0362	0.0347	0.0345	0.0291
$\frac{1}{4}$	0.0231	0.0222	0.0221	0.0186

An example of this will perhaps make this point clear. A 1¼-inch crucible steel rope 6 x 19 runs over a 3-foot sheave and drum on a machine designed to lift 10 tons. According to the tables furnished by rope manufacturers, this rope has a strength of 50 tons, which would give a factor of safety of 5. We will assume that the factor 5 is as small as it is advisable to use for this particular service. What we actually have, however, is this:

Stress on rope due to load to be lifted.......... = 10.00 tons
Stress on rope due to bending over 3-foot sheave. = 7.25 tons

Total stress .... = 17.25 tons.

This gives a factor of safety of less than 3, which is altogether too small, showing how necessary it is to take into account the bending stress due to winding around a pulley or drum. It would be necessary to use in this case either a larger rope and larger sheaves and drums, or a stronger rope and sheaves and drums enough larger to reduce the bending stress to a smaller amount. A 1¼-inch plow steel rope, 6 x 19, has a strength of 67 tons, and with a factor of safety of 5 gives a working stress of 13.4 tons. The problem could then be solved as follows:

Stress on rope due to load to be lifted.......... = 10.00 tons
Stress on rope due to bending over 6-foot 6-inch sheave .... = 3.36 tons

Total stress .... = 13.36 tons.

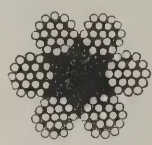
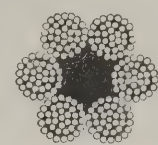


TABLE II. STRENGTH OF 6x19 AND 6x37 ROPES.



Diameter in Inches.	Approximate Circumference in Inches.	Weight per Foot in Pounds.	Approximate Breaking Stress in Tons of 2000 Pounds. Iron.	Approximate Breaking Stress in Tons of 2000 Pounds. Crucible Steel.	Approximate Breaking Stress in Tons of 2000 Pounds. Plow Steel.
$2\frac{3}{4}$	$8\frac{5}{8}$	11.95	114	228	305
$2\frac{1}{2}$	$7\frac{3}{4}$	9.85	95	190	254
$2\frac{1}{4}$	$7\frac{1}{8}$	8.00	78	156	208
2	$6\frac{1}{4}$	6.30	62	124	165
$1\frac{3}{4}$	$5\frac{1}{2}$	4.85	48	96	128
$1\frac{5}{8}$	5	4.15	42	84	111
$1\frac{1}{2}$	$4\frac{3}{4}$	3.55	36	72	96
$1\frac{3}{8}$	$4\frac{1}{4}$	3.00	31	62	82
$1\frac{1}{4}$	4	2.45	25	50	67
$1\frac{1}{8}$	$3\frac{1}{2}$	2.00	21	42	56
1	3	1.58	17	34	44
$\frac{7}{8}$	$2\frac{3}{4}$	1.20	13	26	34
$\frac{3}{4}$	$2\frac{1}{4}$	0.89	9.7	19.4	25
$\frac{5}{8}$	2	0.62	6.8	13.6	18
$\frac{9}{16}$	$1\frac{3}{4}$	0.50	5.5	11.0	14.5
$\frac{1}{2}$	$1\frac{1}{2}$	0.39	4.4	8.8	11.4
$\frac{7}{16}$	$1\frac{1}{4}$	0.30	3 4	6.8	8.85
$\frac{3}{8}$	$1\frac{1}{8}$	0.22	2.5	5.0	6.55
$\frac{5}{16}$	1	0.15	1.7	3.4	4.50
$\frac{1}{4}$	$\frac{3}{4}$	0.10	1.2	2.4	3.00

Note that the sheave had to be increased to more than double its original size to reduce the stress sufficiently. The bending stresses given in the two cases outlined above are the actual stresses that any rope of the construction noted would have. The comparison above shows how vital it is that the bending stresses be carefully considered.

For the purpose of determining what the stress is, the writer has plotted curves for various kinds of commercial ropes of standard makers and various constructions. These curves, given in the Data Sheet, show graphically the effect of the different sizes of sheaves on different ropes, so that it is possible for anyone to look at the curves and tell at a glance exactly what bending stress is put on the rope. For example, take the curves for 6 x 19 ropes. There are two sets of curves for this kind of rope, one plotted to show the relation between the diameter of rope and the bending stress, and the other between the diameter of rope and the size of the sheave. With any two factors known, the third can easily

* Address: 38 Lovell St., Worcester, Mass.
† James F. Howe was born in Manchester, N. H., in 1878. He took a four years' course at the Worcester Polytechnic Institute and graduated with the degree of S. B.; the degree of M. E. was afterwards conferred upon him. He has been employed by the American Steel & Wire Co. in the capacities of draftsman and designer, assistant superintendent of wire rope manufacturing, superintendent of wire rope manufacturing, and at the present time is a wire rope engineer with the company.

be obtained. Suppose that we desire to use a 1-inch diameter, 6 x 19 rope, of a strength of 34 tons to hoist a load of 4 tons. What is the minimum size sheave that can be used with a factor of safety of 5?

34 tons divided by 5... = 6.8 tons total permissible stress
Direct load .... = 4.0 tons

Difference ...... = 2.8 tons permissible bending stress.

Using the diagram for 6 x 19 rope, we find that the line representing 2.8 tons stress intersects the line for 1-inch rope on the curve marked 4 feet. Consequently we will require a sheave 4 feet in diameter.

We can reverse the question. A 6 x 19 rope, 1 inch in diameter, is to be run over a 3-foot sheave; what load will it lift, assuming a factor of safety of 5 and a strength of rope given as 34 tons? Referring to the curves for 6 x 19 rope, we find by following the line for 1-inch rope until it intersects the line for a 3-foot sheave that the bending stress lies between the curves for 3 tons and 4 tons. By proportioning, we find that it is about 3.7 tons.

34 tons divided by 5... = 6.8 tons total permissible stress
Deducting .... 3.7 tons bending stress

Difference ...... = 3.1 tons allowable working load.

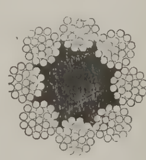
Calculations to Obtain Curves.

The method of calculating these curves is as follows:

Let S = stress per square inch,
E = Young's modulus of elasticity of steel = 29,000,000,
E_r = modulus of elasticity of the rope as a whole,
d = diameter of wire of rope in inches,
d_r = diameter of rope in inches,
D = diameter of sheave or drum in inches.

E_r is a function of E, that is, it is dependent upon its value. E_r is less than E on account of the structure of a rope, and varies with the flexibility of same. A low modulus is indicative of a flexible rope and *vice versa.* In considering this problem, the writer takes into account the modulus of elasticity E_r of the rope as a whole. This conception is different from the ordinary conception of the modulus of elasticity, but is perfectly feasible, as the modulus of elasticity is, strictly speaking, the ratio between the force applied to any material per square inch and the amount of elongation expressed as a fraction of the original length.

TABLE III. STRENGTH OF 8 x 19 ROPES.



Diameter in Inches.	Approximate Circumference in Inches.	Weight per Foot in Pounds.	Approximate Breaking Stress in Tons of 20°0 Pounds. Crucible Steel.	Approximate Breaking Stress in Tons of 2000 Pounds. Plow Steel.
1 1/2	4 3/4	3.48	65	86
1 3/8	4 1/4	2.51	56	74
1 1/4	4	2.13	45	60
1 1/8	3 1/2	1.82	38	50
1	3	1.32	27	35
7/8	2 3/4	1.05	21	27
3/4	2 1/4	0.89	16.5	21
5/8	2	0.53	11.6	15
9/16	1 3/4	0.43	9.4	12.3
1/2	1 1/2	0.31	6.6	8.55
7/16	1 1/4	0.27	6.1	7.95
3/8	1 1/8	0.18	3.3	4.25
5/16	1	0.12	2.2	2.92
1/4	3/4	0.066	1.6	1.95

The stress produced in a round bar of the diameter d_1, when bent around a sheave of diameter D, is given by the well-known formula:

$$S = E \frac{d_1}{D}. \qquad (1)$$

If for d_1 we substitute d, the diameter of the wire in rope, and for E the modulus of elasticity of the rope E_r, we have:

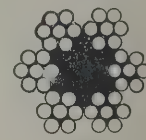
$$S = E_r \frac{d}{D}. \qquad (2)$$

From this formula we can get the required stress per square inch, if we know E_r and d. The following values of d and E_r have been calculated by the writer from various data:

For 6 x 7 rope, diameter of single wire = 0.1059 d_r
" 6 x 19 " " " " = 0.0629 d_r
" 6 x 37 " " " " = 0.0450 d_r
" 8 x 19 " " " " = 0.0499 d_r

Allowance has been made in these values for the angle of twist of the strands and wires, which decreases the size of the wire somewhat in any given rope.

TABLE IV. STRENGTH OF 6 x 7 ROPES.



Diameter in Inches.	Approximate Circumference in Inches.	Weight per Foot in Pounds.	Approximate Breaking Stress in Tons of 2000 Pounds. Iron.	Approximate Breaking Stress in Tons of 2000 Pounds. Crucible Steel.	Approximate Breaking Stress in Tons of 2000 Pounds. Plow Steel.
1 1/2	4 3/4	3.55	34	68	91
1 3/8	4 1/4	3.00	29	58	78
1 1/4	4	2.45	24	48	64
1 1/8	3 1/2	2.00	20	40	53
1	3	1.58	16	32	42
7/8	2 3/4	1.20	12	24	32
3/4	2 1/4	0.89	9.3	18.6	24
11/16	2 1/8	0.75	7.9	15.8	21
5/8	2	0.62	6.6	13.2	17
9/16	1 3/4	0.50	5.3	10.6	14
1/2	1 1/2	0.39	4.2	8.4	11
7/16	1 1/4	0.30	3.3	6.6	8.55
3/8	1 1/8	0 22	2.4	4.8	6.35
5/16	1	0 15	1.7	3.4	4.35
9/32	7/8	0.125	1.4	2.8	3.65

The values of E_r which the writer has obtained by theoretical calculation are:

For 6 x 7 rope, E_r = 13,700,000
" 6 x 19 " E_r = 12,000,000
" 6 x 37 " E_r = 11,300,000
" 8 x 19 " E_r = 11,000,000

These values of E_r have been checked from several sources and represent average commercial ropes in use to-day. Taking an actual case to show how to get the stress, we may assume that we have a case of ½-inch diameter, 6 x 7 rope, on a 10-foot sheave. What is the stress? Using formula (2) we have:

$$S = \frac{13{,}700{,}000 \times 1\frac{1}{2} \times 0.1059}{12 \times 10}$$

= 18,100 pounds per square inch approx.

Area of a 1½-inch, 6 x 7 rope = 0.8334 square inch (see Table I.).

Hence, stress in rope = 0.8334 × 18,100
= 15,080 pounds = 7.54 tons bending stress.

Values for the other sizes of sheaves and drums were obtained in a similar manner for sufficient points to plot the curves given. It will be noted that these curves are of the form of a parabola, and the stresses of any two sizes of rope are to one another as the cube of the diameter, that is, on a given size sheave a rope 1 inch in diameter has eight times the stress of a ½-inch rope over the same diameter pulley.

Tables II., III. and IV. give the strength of the various kinds of ropes which are adopted as standards in the United States.

* * *

Disappearing paper is now quite extensively (?) used in letter writing. It is prepared by being steeped in sulphuric acid, after which it is dried and glazed, the acid being neutralized by ammonia vapor. After a certain number of days or weeks the paper falls to pieces.—*Mining Reporter.*

LETTERS UPON PRACTICAL SUBJECTS.

GEAR SHAPING ATTACHMENT FOR THE SLOTTER.

The accompanying line cut and halftone show an attachment for the slotter for cutting the teeth in quadrants. Referring first to the line cut, Fig. 2, *A* is a forging made as shown in the detailed view, having a tongue to fit into the slotter table. At *C* is shown another forging, bored to fit the projecting pin of *A*. Into this forging *C* the arms *E* are inserted, having a ball seat on each side, and nuts made to correspond. While this refinement of the construction may not be a necessity, it still is an improvement. For various sizes of quadrants it is necessary to have arms of different lengths.

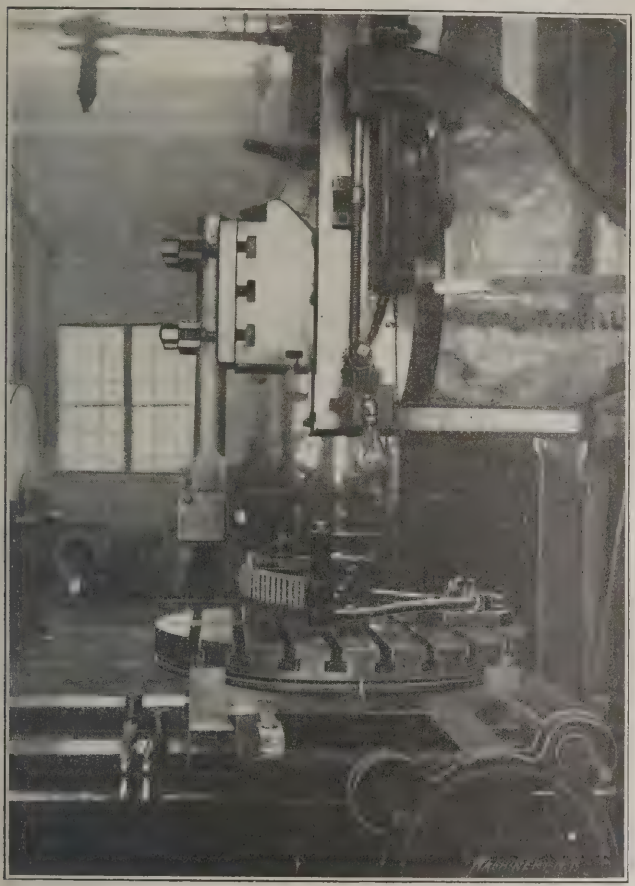


Fig. 1. Gear Shaping Attachment for the Slotter.

The quadrants are first machined on the sides and faces, and after that two holes are drilled and studs *G* made, having a nice fit in these holes, the studs being as long as required to take one or more gear sectors at a time. The first two teeth should be laid off on the quadrant if there is no templet having the teeth already cut. It is advisable, however, to make a templet out of a piece of steel about 1/8 inch thick. When making the templet, the sheet steel may be bolted to the quadrant, the teeth of which are to be cut. The teeth are then laid out to the proper shape and slotted at the same time as the teeth are cut in the quadrant. When this templet is once made, it will last for years, and it will save the necessity of laying out any teeth at all on the quadrant to be cut.

However, if we assume that no templet is at hand, we lay out the first two teeth, and after adjusting the piece by oscillating the quadrant back and forth and noting that the tool point is in correct position, the quadrant is clamped down to the table with two clamps. The first tooth is then cut.

While the first tooth is cut the carriage of the machine is brought up tightly against a stop set on the bed. This stop is shown on the left-hand way of the machine in the halftone. As soon as the first tooth is cut, the tool is left in the space having been cut. The clamps holding the device to the table of the machine are loosened sufficiently to allow the quadrant to be moved on the pivot, and the carriage is then moved away from the stop a distance equal to the pitch of the teeth to be cut. As the tool is left in place in the quadrant, the movement of the carriage evidently turns the device around its pivot, thus, in fact, indexing the quadrant for the next tooth to be cut. When the carriage has been moved what is supposed to be the correct amount, corresponding to the pitch, the clamps are again tightened, the tool is raised above the quadrant, and the carriage brought back against the stop. The tool now ought to be exactly over the second space laid out on the quadrant, and ready to cut the second tooth. By having the next tooth laid out, it is easy to see whether the carriage has been moved the correct distance. If it has, a small plug may be turned about 1½ inch long and with a diameter equal to the amount that it was necessary to move the carriage away from the stop in order to index for the next tooth. When this plug is made, it is stamped with the radius and the pitch of the quadrant, and can be used for all other quadrants of the same kind in the future. All the other teeth in the quadrant are cut by proceeding for each tooth in the same manner as outlined for the first two teeth. If it is found that the radius of the quadrant on which the teeth are to be cut is too large, so that the pivot block *A* cannot be bolted to the table of the machine, an extension pivot block can be made to extend sufficiently over the edge of the table,

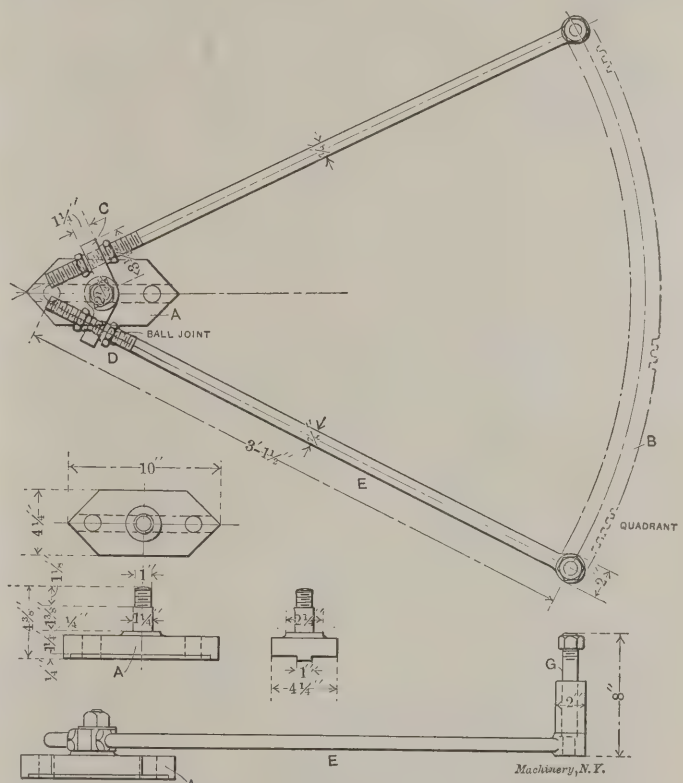


Fig. 2. Details of Gear Shaping Attachment.

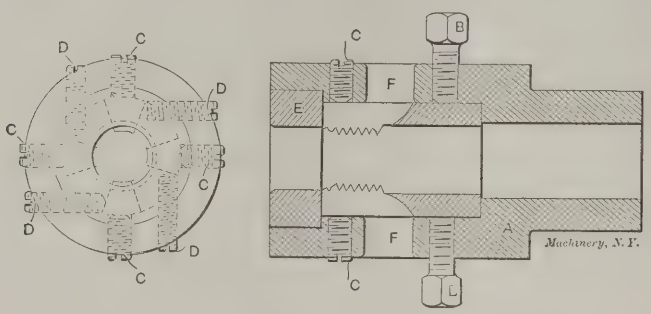
so that the part being machined can be placed on the table, which of course is necessary in order to obtain satisfactory support for the work. This method is much quicker than milling. By actual test I find that it saves 40 per cent of the time required in milling. M. H. W.

HOLDER FOR SPRING SCREW THREADING DIES.

From time to time some one comes forth and tells us in the mechanical papers a great many things about screw-threading dies. It is not my intention to expound that theory here, but I wish to describe a die holder by the use of which spring screw dies can be used to much better advantage than they sometimes are. Suppose that a screw is to be made on the screw machine, and that it is required that the thread must be exact in lead, so that it can be screwed into a tapped hole and fit properly all the way in, and that the thread shall be concentric with the body of the screw, so that when it is being screwed into place, the piece it is to hold will be located in its proper location. Some adjustable dies will cut this

thread fairly well, but solid dies do not, as a rule. The worst die to use is the spring screw die, whose slender jaws spring away from the cut and produce an incorrect pitch. I have seen screws cut in this manner that would not enter a tapped hole but three or four threads, but a thin gage would fit nicely all the way up. This weak point of the slender jaws can be made an advantageous feature if a proper holder is made, into which the die is placed, and necessary screws used to adjust and hold the prongs. Such a holder is shown in the cut. This method of holding the die gives to the spring screw die all the qualities of a solid die without losing any of the adjustable qualities of the spring die.

It will be seen from the cut that the die is held rigidly within a solid holder A, the shank of which fits the regular die



Holder for Spring Screw Threading Dies.

holder or chuck. The screws B hold the die in place. The screws C adjust the die in regard to the size independently of one another. These separate adjustments are convenient, for it is often necessary to adjust one jaw more than another. The screws D give a backing to the jaws and prevent them from springing away from the cut. A hardened bushing E, held in front of the die, guides the work when entering the die so that the thread will be concentric with the blank. The holes F permit the oil to enter the die and the chips to pass away from the cut.

When adjusting the die, use a master screw. Screw it into the die through the bushing and adjust the jaws until they barely touch the thread of the master screw. The die is then ready for use. The first screw made should be gaged, and readjustment should be made according to requirements. A little practice will enable the operator to adjust the die without any trouble. This holder will also be found to be convenient for holding the die when rehobbing it. Often one jaw needs more hobbing than another, and by means of the screws C this can be accomplished. The bushing E will be found to be an excellent guide for the hob.

The most satisfactory way of annealing dies to prevent them from cracking when they are hardened after rehobbing, is to pack them in a regular case-hardening box with charcoal, and put them in a furnace with a regular charge, and if possible permit the box to remain in the furnace to cool. If this, however, is not convenient, remove the box with the charge and set it aside in a warm place until the dies are cool enough to be taken out. Do not allow the air to strike the dies while they are hot. If these directions are properly followed, this method will tend to keep the dies from cracking, and they can be used over and over as long as the threads last. The die holder shown has been in use over twenty years, which is long enough to prove that it gives satisfaction.

W. B. M.

"R. S." ONCE MORE REFUTED.

In the April issue of MACHINERY "R. S." gives a suggestion for finding the radius of an arc when its length and the length of the chord are given. I would like to say thereto that his method is incapable of solution. Let C be the length of the given chord, x the height of the given arc, and R the required radius; "R. S." then says that he now has two unknown quantities, R and x, and by finding two equations involving these two quantities, the problem may be solved. The equations he gives are:

$$R^2 = \left(\frac{C}{2}\right)^2 + (R - x)^2 \qquad (1)$$

$$(2\,R - x)\,x = \left(\frac{C}{2}\right)^2 \qquad (2)$$

The first is derived from the geometric proposition that the square of the hypotenuse of a right angle triangle equals the sum of the squares of the other two sides, and the second is derived from the proposition that if two chords intersect within a circle, the products of their respective segments are equal. Although these equations are geometrically correct, they cannot be solved algebraically, as they are not independent equations, *i.e.*, they do not show different relations between R and x. This is more easily seen by reducing them to their simplest form:

$$R^2 = \left(\frac{C}{2}\right)^2 + (R - x)^2 \qquad (1)$$

$$R^2 = \frac{C^2}{4} + R^2 - 2\,R\,x + x^2$$

$$2\,R\,x - x^2 = \frac{C^2}{4};\ 8\,R\,x - 4\,x^2 = C^2$$

$$(2\,R - x)\,x = \left(\frac{C}{2}\right)^2 \qquad (2)$$

$$2\,R\,x - x^2 = \left(\frac{C}{2}\right)^2 = \frac{C^2}{4}$$

$$8\,R\,x - 4\,x^2 = C^2$$

Both thus reduce themselves to $8\,R\,x - 4\,x^2 = C^2$, indicating that they are mutually dependent and cannot be solved by any method for simultaneous equations.

It is safe to state that there is no elementary proposition by which R can be found in terms of C and the length of the arc alone; in fact, "R. S." tries by his method to find it in terms of C alone, which is quite a ridiculous assumption to begin with.

F. WALSLEBEN.

Brooklyn, N. Y.

[It would seem that "R. S." is quite unfortunate in his alleged discoveries. The readers of MACHINERY have a way of "sitting on him" that would discourage a less indefatigable investigator.—EDITOR.]

STEAM REVERSING VALVE FOR HOISTING ENGINE.

The accompanying Figs., 1 to 4, show the design of valves used on a small hoisting engine with 8 x 8-inch cylinders. The design is very simple, but I do not know who the originator was. The engine is built by the Victorian Foundry Company, Ottawa, for the Department of Public Works, to designs furnished by the department.

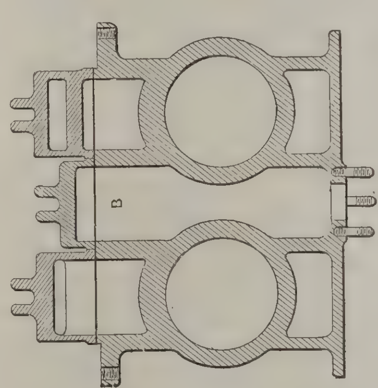


Fig. 1.

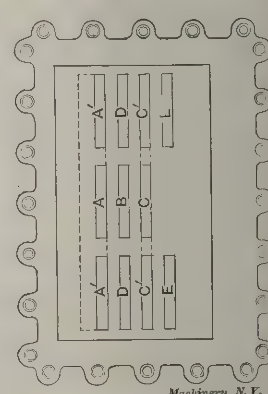


Fig. 2.

Fig. 1 shows section through exhaust passage B and steam ports; Fig. 2 shows valve seats and port openings; Fig. 3 shows section through distributing valve and ports A and C, also the exhaust passage; and Fig. 4 shows section through main valve and cylinder.

With the distributing valve in the position shown in Fig. 3, steam is admitted from the steam chest to port A, and through the passage shown into the main valve, Fig. 4; then through port D into cylinder. Exhaust is through port E into C_1, and then through passage to C and through the distributing valve down exhaust passage B. With the distributing valve moved

forward, the steam is admitted to C, C_1 and E and the cylinder exhaust takes place through D, A_1, A and B.

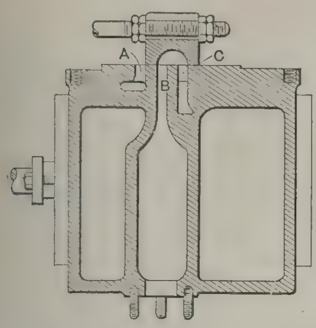


Fig. 3.

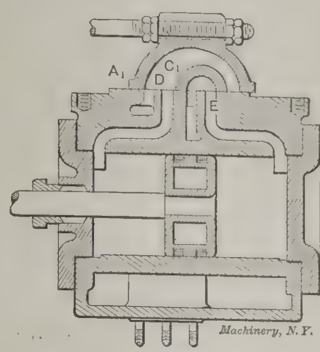


Fig. 4.

The simple action commends itself for small engines, as only one eccentric and connections are necessary for each cylinder.

Ottawa, Can. J. S. IMLACH.

MILLING MACHINE BORING TOOL HOLDER.

The adjustable milling machine boring tool shown in the halftone, Fig. 1, and the line cut, Fig. 2, has proven very useful on jig and die work and can be used to advantage on any work of boring where accuracy is an important factor. A

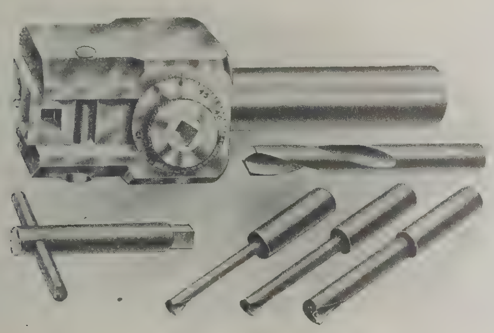


Fig. 1. Milling Machine Boring Tool Holder.

tool of the dimensions shown will bore holes from ¼ to 1 inch in diameter, and by making split bushings and using a small drill to start with, very much smaller holes can be bored. The tool-holder is made of tool steel throughout.

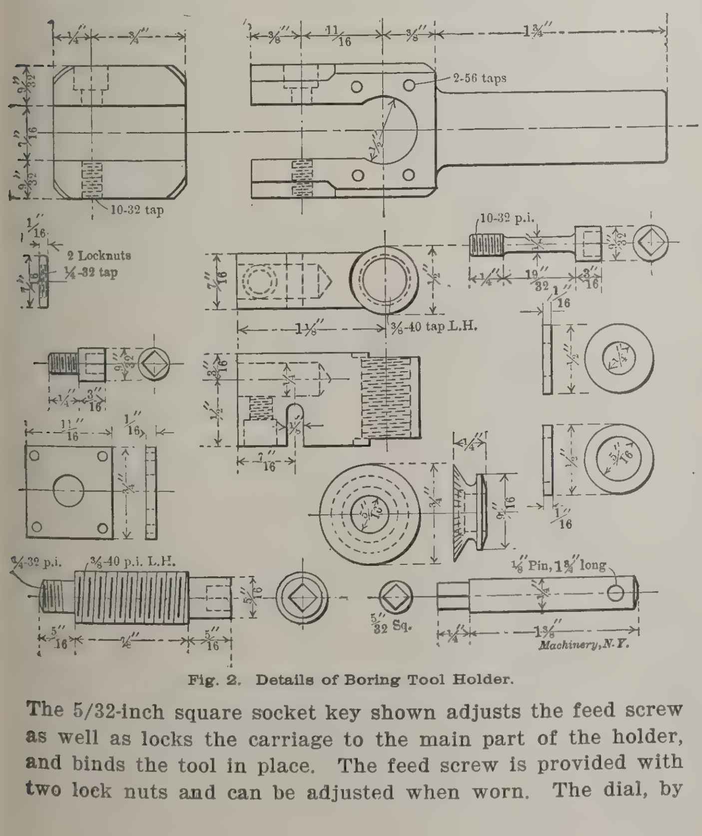


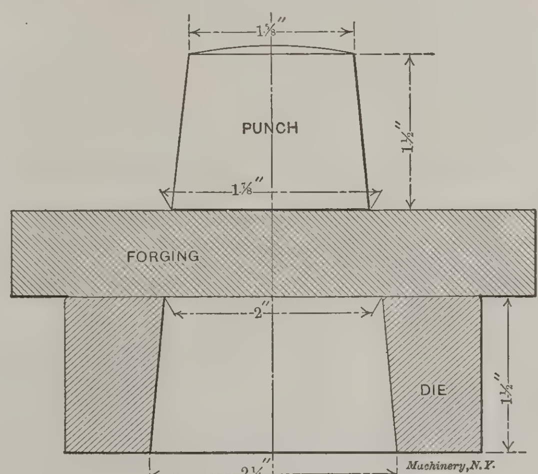
Fig. 2. Details of Boring Tool Holder.

The 5/32-inch square socket key shown adjusts the feed screw as well as locks the carriage to the main part of the holder, and binds the tool in place. The feed screw is provided with two lock nuts and can be adjusted when worn. The dial, by means of which the amount that the feed screw is fed in is determined, is graduated into 50 divisions, each one representing 0.0005. The operator is therefore able to determine very small increases in the diameter of the hole to be bored. The screw itself is threaded left hand which permits right-hand movements of the dial. J. N. EAGAN.

MAKING COLLARS WITH THE STEAM HAMMER.

Some years ago I was called upon to make a large number of collars of different sizes, and it was necessary that these collars should be made cheaply. The firm that I was with had been buying drop forgings for these collars, but I figured that it would be cheaper to make them in a different manner. Previous to my time in this particular shop they had used a great deal of round machine steel in various sizes from 2 to 4 inches in diameter, and they used to throw the ends of the bars out in the yard until there had accumulated a good-sized pile. This scrap I used for making collars.

I first made a set of dies of different sizes from 1½ to 4½ inches inside diameter, making the holes taper as shown in the cut. I then made a lot of short punches to correspond to these dies, but ⅛ inch smaller in diameter than the holes in the latter. None of the punches were longer than 2 inches, and some of them were not longer than 1¼ inch. These were also made taper, as shown in the cut. I then started to make the collars. After ascertaining the amount of material needed for a certain size of collar, I cut off three, four or five blanks from a piece of shafting at one heat. I then threw them back in the fire and took them one at a time to the steam hammer, hammering them down until they were about the right thickness, preferably a little thicker than the size



Punch and Die for Making Collars.

called for. I then rounded them up and flattened them again, placed the die in the steam hammer with the heated blank on it and the punch on top, as shown in the cut, and with one or two moderately hard blows of the hammer I drove the punch through very easily, and the collar was forged. For varying the size of the holes in the collars to be made, I made some taper pins of crucible tool steel to drive into the holes after they had been punched, so that I could make collars of any size and thickness. The plan was so successful, that after having used up the scrap steel, I used regular bar stock in making these collars. I also used the punchings from the larger collars for making smaller ones, so there was very little waste; in fact, I figured there was less than 15 per cent waste in all.

If the punch should happen to shear the die at any time, the blacksmith could work the die over in a few minutes by closing it up and then driving the punch in until the hole is again of the right size. It is not necessary to have sharp edges on the die and punch, but it is necessary to have the bottom and top of the punch as parallel as possible, so as to prevent the hammer from driving the punch to one side. Care should be taken that the punch is central on the blank before the hammer is applied, so that shearing the die will be avoided. I have punched over 700 collars on one die without any trouble.

Chicago, Ill. GEORGE T. COLES.

STRENGTH OF BOILER JOINTS.

It was with interest that I read the article in your February issue, Engineering Edition, respecting the above, and I would like to show (what is probably not known to all your readers) that the stress in the second row of rivets always amounts to more than in the first row. This is the case when a triple joint is used, having a narrow outer butt strap and a wide one inside, and when the pitch in the second row is half the pitch of the first, and all rivets have the same diameter.

I will now show how to calculate the stress of the shell plate at both rows of rivets, and for the sake of convenience, I take the joint shown in Fig. 1, same as in your February

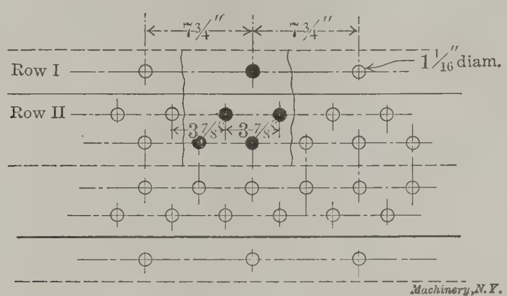


Fig. 1. Joint suggested in Article in February Issue.

issue, *i. e.*: shell, ⅝ inch; rivets, 1 1-16 inch = 1.06 inch, about; radius of shell, 29 inches; pitch, 7¾ inches; pressure, 200 pounds per square inch.

Row 1. Pull along one pitch = 7.75 × 29 × 200 = 45,000 lbs.

Length of plate = 7¾ — 1 1-16 = 6.68 inches.

$$\text{Tearing of plate} = \frac{45,000}{6.68 \times 0.625} = 10,780 \text{ lbs. per sq. in.}$$

$$\text{Shearing of rivets} = \frac{45,000}{9 \times \frac{\pi}{4} \times 1.06^2} = 5,650 \text{ lbs. per sq. in.}$$

Row II. Pull in second row of rivets is 45,000 lbs. less the amount taken away by rivet in (I); that is, the amount transmitted in row I through one rivet to the butt straps.

$$45,000 - 5,650 \times \frac{\pi}{4} \times 1.06^2 = 45,000 - 5,000 = 40,000 \text{ lbs.}$$

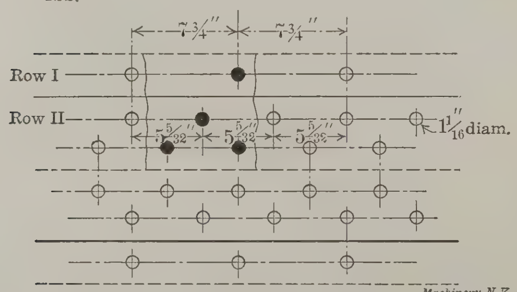


Fig. 2. Joint Redesigned to give less Stress in Row II than in Row I.

Length of plate = 7¾ — 2 × 1 1-16 inch = 5⅝ = 5.625 inches.

$$\text{Tearing of plate} = \frac{40,000}{5.625 \times 0.625} = 11,380 \text{ lbs. per sq. in.}$$

or about 5½ per cent more than in row I.

To avoid this there are two methods possible; one of them is shown in Fig. 2. Use the same pitch at row I, but increase the pitch at rows II. and III., all rivets remaining the same diameter.

Row I. Pull along one pitch = 7.75 × 29 × 200 = 45,000 lbs.

$$\text{Tearing of plate} = \frac{45,000}{6.68 \times 0.625} = 10,780 \text{ lbs. per sq. in.}$$

$$\text{Shearing of rivets} = \frac{45,000}{7 \times \frac{\pi}{4} \times 1.06^2} = 7,275 \text{ lbs. per sq. in.}$$

$$\text{Factor of safety} = \frac{38,000}{7,275} = 5.22$$

$$\text{Row II. Pull along one pitch} = 45,000 - 7,275 \times \frac{\pi}{4} \times 1.06^2 = 38,575 \text{ lbs.}$$

Length of plate = 7.75 — 1.5 × 1.06 = 7.75 — 1.6 = 6.15 inches.

$$\text{Tearing of plate} = \frac{38,575}{6.15 \times 0.625} = 10,060 \text{ lbs per sq. in.}$$

or 6½ per cent less than in row I.

A second method, shown in Fig. 3, consists in increasing the pitch and diameter of rivets in the first row, or using smaller rivets in the second and third rows. Of course, this is somewhat awkward, on account of it being necessary to change the riveting tools (but on the European continent this is the usual practice) for the two sizes of rivets. If, however, we keep the 1 1-16 inch rivets in the first row, and use 15-16 inch rivets in the second and third rows, we get:

Row I. Pull along one pitch = 7.75 × 29 × 200 = 45,000 lbs.

$$\text{Area of rivets} = \left(1 \times \frac{\pi}{4} \times 1.06^2\right) + \left(8 \times \frac{\pi}{4} \times 0.94^2\right) = 0.883 + 5.550 = 6.433 \text{ sq. in.}$$

Length of plate = 7¾ — 1 1-16 = 6.68 inches.

$$\text{Tearing of plate} = \frac{45,000}{6.68 \times 0.625} = 10,770 \text{ lbs per sq. in.}$$

$$\text{Shearing of rivets} = \frac{45,000}{6.433} = 7,000 \text{ lbs. per sq. in.}$$

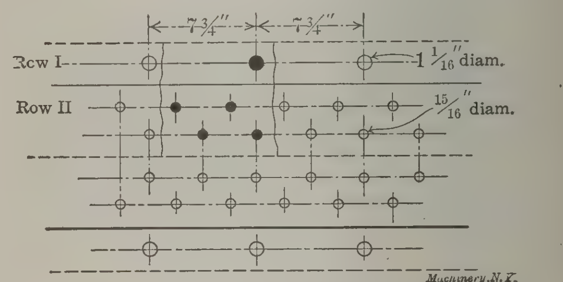


Fig. 3. A Joint in which the Stresses are nearly Equalized.

Row II. Pull = 45,000 — 0.883 × 7,000 = 38,820 lbs.

Length of plate = 7.75 — 2 × 15-16 = 5.875 inches.

$$\text{Tearing of plate} = \frac{38,820}{5.875 \times 0.625} = 10,580 \text{ lbs. per sq. in.}$$

or 1¾ per cent less than in row I.

If instead of using smaller diameter rivets in the second and third rows we keep 1 1-16 inch rivets, but increase the diameter of rivets in the first row to 1 3-16 inch, also the pitch to give the same percentage, similar results would be obtained. In a triple butt joint with straps of equal width, the stress in the second row would always be less than in the first row; on this account therefore, it is unnecessary to make any calculations of row II.

It appears to me that here in England it is customary to use higher working stresses than in the United States; while there, according to the article, plates are used with a tensile strength of 55,000 pounds per square inch, with a factor of safety of 5, we use here plates of not less than 60,000 pounds, allowing a factor of safety of 5 for double butt joints, and a factor of safety of 4½ for triple butt joints. Here we never use iron rivets, but always steel rivets, with a shearing strength of 50,000 pounds per square inch, and a factor of safety of 5, which equals 10,000 pounds per square inch, under pressure. It is also our rule here to take the diameter of the steel rivets from $1.1\sqrt{T}$ to $1.2\sqrt{T}$, where T equals thickness of plate in inches; so that in the above case we should have used $1.2\sqrt{0.625}$ = 15-16 inches for the diameter of the rivets, and the riveting as shown in Fig. 2.

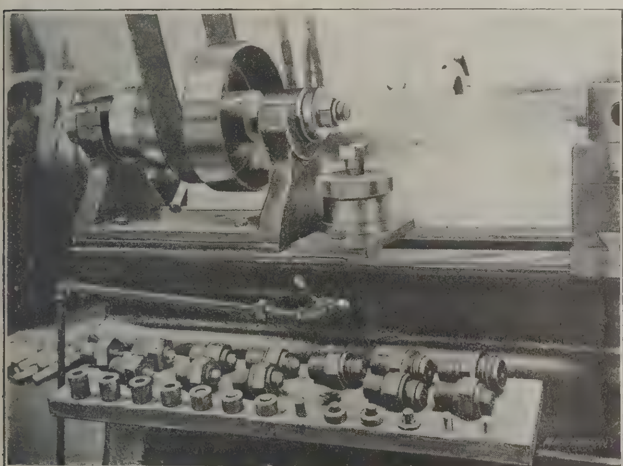
The thickness of the butt straps we take as about 0.625 T; the outer butt strap is in no case, however, thinner than ⅛ of the pitch in row II, as of course it would be very difficult to calk any thinner butt strap.

A. WIND.

Wolverhampton, England.

TIME-SAVING DEVICE FOR NUT FACING MACHINE.

The accompanying cut shows an addition to a nut facing machine which almost doubles its output. It used to take almost as long to remove a nut from the arbor as it did to machine it, but by the use of the air cylinder shown, placed on a block on the bed of the machine, the operator with one hand reverses the belt and with the other turns on the air which causes the piston to ascend. The top part of the piston is provided with a piece machined to fit the hexagon nut and having a projection turned to fit a hole bored in the piston rod. When the piston with this top piece reaches the nut, it grips it, and owing to the reversed motion of the spindle of the machine, the nut is quickly unscrewed. Another nut is quickly screwed on the spindle in a similar way. The air is used only to raise the piston, a spring being used to force it down. For different sizes of nuts a number of bushings are used, as shown in the lower part of the cut. These bushings are placed between the V-piece gripping the nut and the piston, in order to raise the V-block up to the required height without necessitating an excessive amount of piston



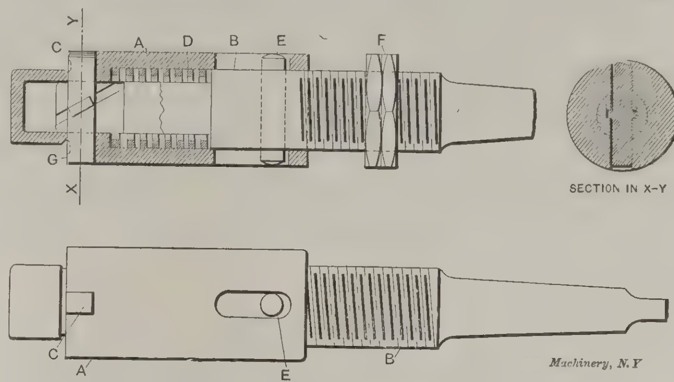
Time-saving Device for Nut Facing Machine.

travel. I am aware that there are better nut facers on the market, but this being a home-made one which serves the purpose all right, the only difficulty to be overcome was the backing off of the nuts, which can be done by the method described without stopping the machine. A little kink in connection with facing nuts which may be of benefit to some one is to face the lower side of the nut first and to have the tool ground in such a manner that the operator can slightly countersink the nut of the threaded hole. By doing this no trouble is ever experienced in getting the nut started on a bolt through the thread being burred. Another kink, when a lot of nuts come for facing which have a very hard scale, is to put them in a flue rattler, if it is a railway shop, or in any other rattler for that matter, and they will come out in as good condition as cold pressed nuts.

M. H. W.

RECESSING TOOL.

The cut herewith shows a design for a special recessing tool, which can be used on an ordinary drilling machine for recessing. The tool will produce accurate results if well made. The cut shows a section of the complete tool which comprises the outer shell *A*, the center piece *B* which fits the drilling machine collet and operates the tool, the cutting tool *C*, a spiral spring *D*, a driving pin *E*, and finally two lock nuts *F*. The tool can, of course, be varied in design to suit the particular work it has to perform. The action is as follows: The piece *B*, which fits into the machine spindle, revolves the outer shell by means of the driving pin *E*. The cutting tool *C* passes through the center of the outer shell and of center piece *B*. The two side pieces on the cutting tool, shown in the section, slide in the two slots provided in the center piece. These slots are cut at a suitable angle, so that when the center piece is forced forward, the slots force the cutting tool outward until the lock nuts come in contact with the end of the shell. The nuts can be set to gage the diameter of the recess required. The end face *G* of the shell takes a bearing on the work to be operated upon. The spiral spring should be strong enough to force the center piece up, when the pressure is released at the driving spindle, to withdraw the cutting tool from the recess. When assembling the tool, care must be exercised to insure that the driving strain comes on the driving pin *E*, and that the slot at the end of the center piece does not bind on the side of the cutting tool, the function of this



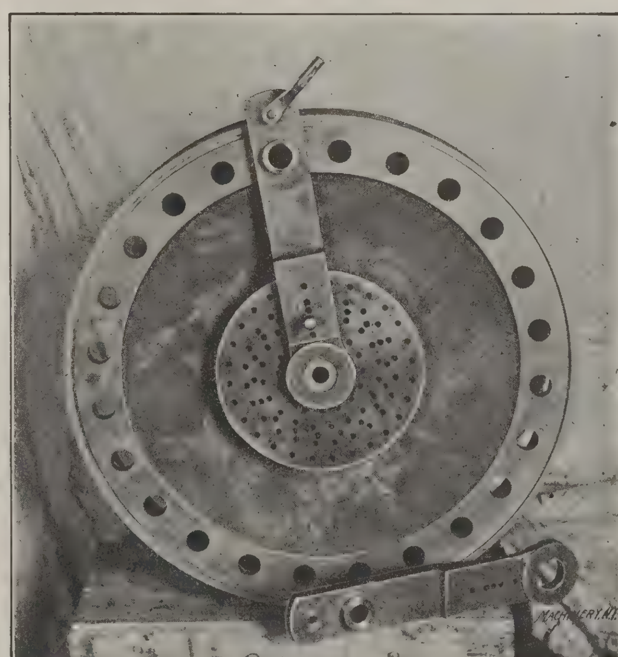
Recessing Tool.

part being only to transmit the feed to the cutting tool and not to drive it. The outer shell is the driving medium and the cutting tool should be a nice sliding fit in the shell. The slot in the shell which receives the driving pin must be a sliding fit and long enough to accommodate the full adjustment of the tool.

CONTRIBUTOR.

FLANGE DRILLING JIG.

The drilling jig shown in the cut is not intended for extreme accuracy, but rather to take in a wide range of work. As the number of holes in the work to be drilled varies, it would cost considerable to make individual jigs to do the same work. The features of this jig are the individual plate, and the removable arm which carries the drill bushing. The plate is held in position by a nut on the under side of the work, and the position of the arm is fixed by a plug which



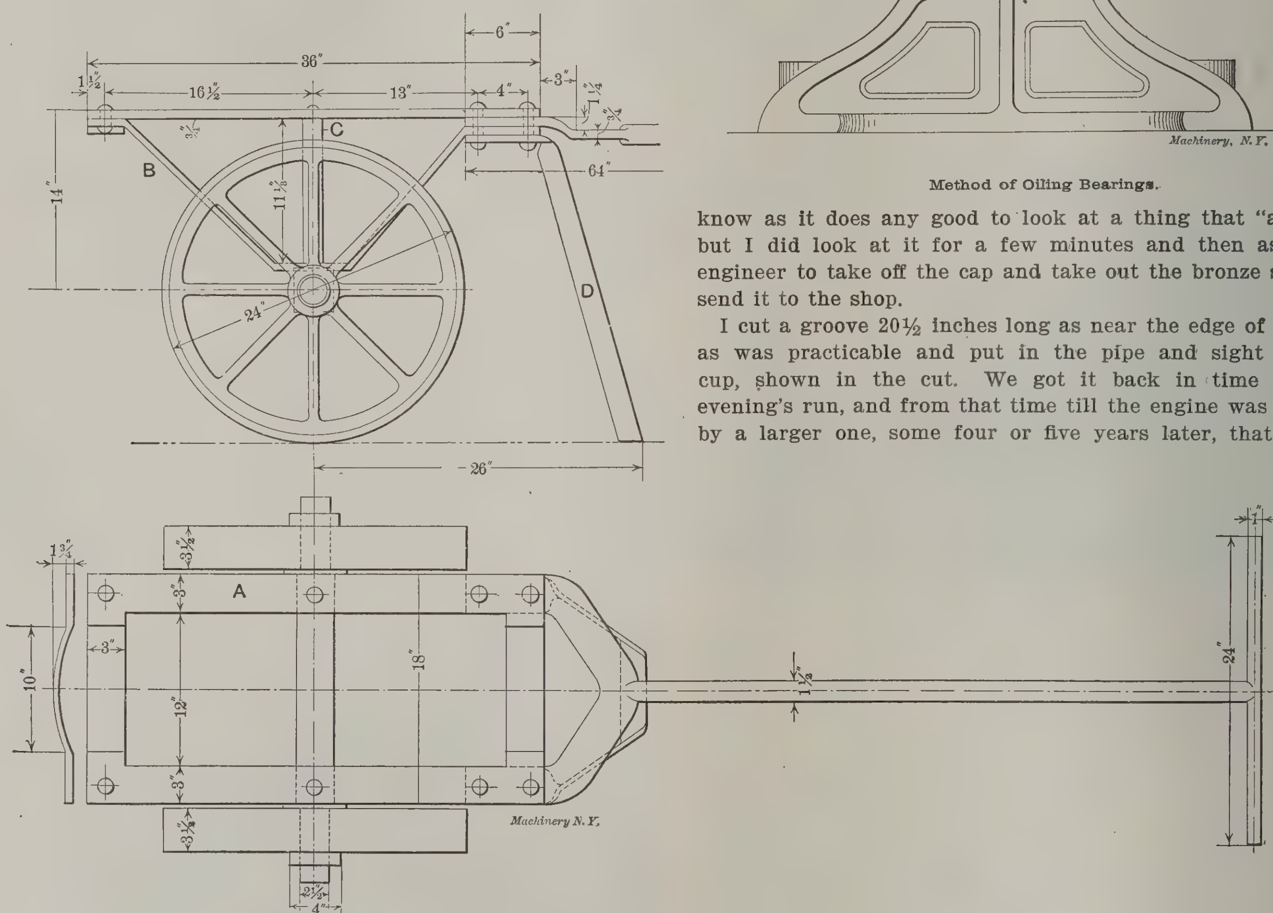
Flange Drilling Jig.

passes through the arm and into the plate. The bolt at the outer end is made of a suitable form to clamp on the under side of the work, and is tightened by the handle shown, which avoids the use of a wrench. By loosening this handle and withdrawing the locating plug, the arm can be turned to the next division, the plug inserted and the hole drilled. Different diameters may be drilled by using arms of suitable length, so the same dividing plate answers for a wide range of sizes. Although the principle of this jig is not new, yet the adaptation is entirely original so far as the writer knows.

Wellsville, N. Y. M. A. PALMER.

SLAB TRUCK FOR FORGE SHOP.

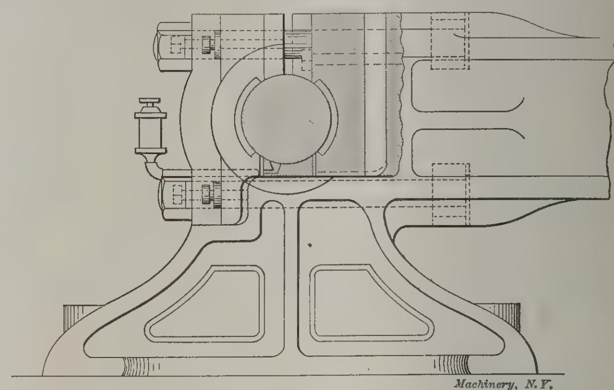
The cut herewith illustrates a slab truck that is made to handle both the hot and cold billets around a forge shop. It is made up entirely of iron, hence there is no danger of destruction when handling billets at a white heat. The height has been designed to conform to that of the furnace door and the top of the bottom die on the steam hammers in use. A heavy hot slab may be pulled from the furnace and wheeled over to the anvil of the steam hammer with greatest ease. The construction is very simple and inexpensive. The axle is made of 3 x 3-inch wrought iron, and the two wheels are 24 inches in diameter, 3½-inch tread, and made of cast iron. The slab rest *A* is made of 3 x ¾-inch wrought iron, supported by the 3 x ¾-inch braces *B*, with a piece of 1 inch wrought iron pipe *C* acting as a strut. The whole is bolted down through the axle by a ⅞-inch bolt passing through the pipe, and each end riveted over. The support *D* is of ¾ x 2-inch wrought iron made in U-shape and is very rigid. The handle is of 1½-inch round wrought iron, welded to a ¾ x 3-inch yoke. The hand bar is 1 inch in diameter by 24 inches long for the accommodation of two men. The truck as a whole has been found very useful and substantial, and since its trial many others have been constructed. T. B. BURNITE.



Slab Truck for the Forge Shop.

OILING BEARINGS.

Having noticed several articles lately in MACHINERY about oiling bearings, I am prompted to give a bit of my experience in that line. Some 20 to 22 years ago we made an engine to run an electric light plant, with cylinder 24 x 48 inches, which was a pretty large one for our small shop to tackle. Soon after it was running, it developed an inordinate desire to heat the main bearing. This bearing was 12 inches in diameter by 21 inches long; the quarter boxes were babbitted, and the bottom shoe was of phosphor bronze 8 inches wide, giving 168 square inches to carry about 18,000 pounds, which would not seem excessive, only a little over 100 pounds to the square inch. The box was equipped with two sight feed oil cups, and had an opening on top 6 x 16 inches down to the shaft. The first regular run it made was only a few hours long—a "moonlight run"— and the engineer managed to keep it going. Soon the runs lengthened, and then the trouble grew serious. One morning after an all-night run I went over to the plant and it seemed as though there was a barrel of tallow on the floor—tallow mixed with black lead, oil, and water (only the water didn't mix), and the box was then too hot to handle. Something had to be done, and as I was practically responsible for the outfit, I felt a trifle worried. I don't



Method of Oiling Bearings.

know as it does any good to look at a thing that "acts up," but I did look at it for a few minutes and then asked the engineer to take off the cap and take out the bronze shoe and send it to the shop.

I cut a groove 20½ inches long as near the edge of the shoe as was practicable and put in the pipe and sight feed oil cup, shown in the cut. We got it back in time for that evening's run, and from that time till the engine was replaced by a larger one, some four or five years later, that bearing was never any warmer than the air in the room. As first made, this bronze shoe was beveled to carry oil under the shaft, and grooved diagonally according to the time-honored custom. We noticed one curious thing about it; if the oil cups on top were set to feeding, oil would run out over the top of the added oil cup at the left, just as much as was delivered by the two on top; stopping the oil from the top resulted in the new oil cup instantly becoming operative again. The engine ran "over"; had it run "under," I would have cut the groove at the other edge, and carried oil to it by drilling all way through the shoe. E. S. NEWTON.

Milwaukee, Wis.

* * *

A soldering fluid which has proved very useful in certain railway shops is made, says the *Street Railway Journal*, by killing two quarts of hydrochloric acid with all the zinc it will take up. Then to the acid a quart of water is added, or it may have to be added before the zinc will fully dissolve. A quart of glycerine which has previously been mixed with a quart of alcohol is then added to the solution. This fluid is used for all kinds of soldering and has been found especially desirable with greasy or dirty connections, as well as for soldering to iron. It is claimed that the glycerine prevents the rust caused by soldering fluids containing hydrochloric acid.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

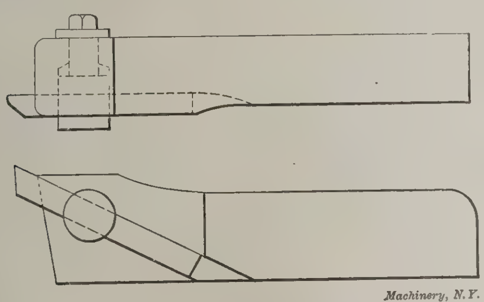
DRAFTING ROOM SCALES FOR COMPARING FULL-SIZE DIMENSIONS.

It is a good idea to have the drafting room fitted with two full-sized scales, one extending the full length, and the other the full height, of the room. These scales need not be graduated very fine—say about every quarter of a foot—but should be figured in such a manner that the figures are legible from any drawing board in the room. This scheme is being adopted quite generally in the technical schools, where the pupils are liable to have a poor conception of large dimensions, and it is sometimes a great help even to those who have had shop and field experience. E. A. PRITCHARD.

Champaign, Ill.

TOOL-HOLDER FOR THE SHAPER.

Feeling the need of a tool-holder that could be worked on a shaper right up to a shoulder without interference from the set screw, I designed the holder shown in the figure. No

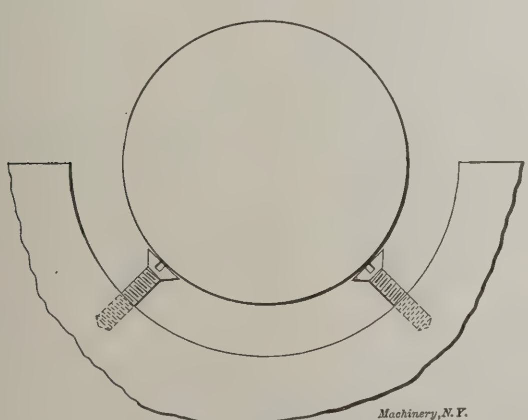


explanation is necessary, though it might be stated that the tool has not only proven successful in its intended field, but efficient for a large variety of lathe work as well.

Middletown, N. Y. DONALD A. HAMPSON.

SUPPORT FOR SHAFT WHEN BABBITTING.

In babbitting boxes for crankshafts, drill with the breast drill two holes about 90 degrees apart and about a quarter of an inch from the outside end of the boxes to be babbitted. These holes are to be tapped for small countersunk head-screws. The shaft can rest on the heads of these screws, and be lined up by adjusting the screws up or down with the fingers or a pair of pliers. After pouring the babbitt, the

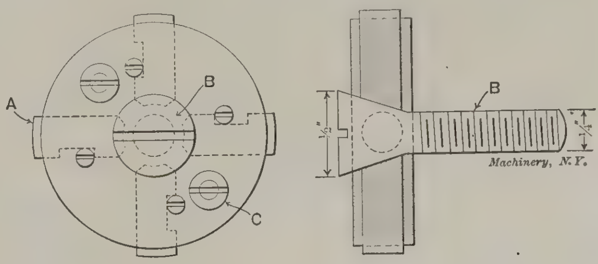


screws may be taken out with a screwdriver, or, if brass screws were used, they might be left in. One convenience of this method is, that after lining up the shaft it may be taken out of the boxes and warmed up before pouring babbitt and be replaced with the assurance that it will still be in line.

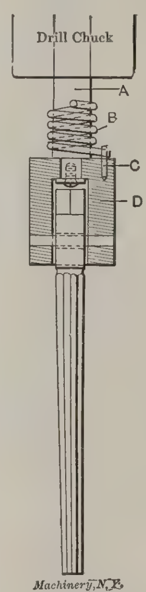
Los Angeles, Cal. STANLEY GOULD.

EXPANDING CHUCK FOR GRINDING MACHINE.

The cut herewith shows an expanding chuck for a Brown & Sharpe universal grinding machine, which I found useful in holding friction washers, etc., when grinding on the face, and I think the idea worth bringing before other readers of MACHINERY. The screw *B* fits the threaded hole in the face-plate of the machine, and, as it is screwed in, forces the pins *A* outward, thus gripping the work. The head of the screw *B* should be hardened and ground to correct taper. The pins *A* should be a good fit in the body, so as to insure accuracy. The



two screws *C* hold the body of the chuck in place, after being located in the center of the face-plate by screw *B*. The sizes of the chucks will vary according to the work to be ground, but a good many jobs can be done by just having sets of pins of different lengths. MACHINIST.

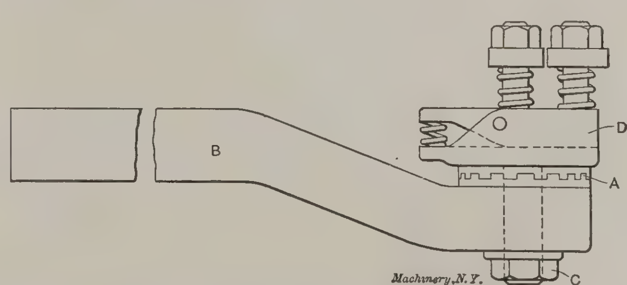


DEVICE FOR USE IN REAMING TAPER HOLES.

The device shown in the cut is handy for use when reaming taper holes on a drill press. The shank *A* is gripped in the chuck of the machine, the spring *B* is fastened to the shank at the top and has a straight portion at the lower end which engages with the driving pin *C*. The end of the shank *A* is a running fit in the body *D*, and is held by a screw and a washer as shown. The reamer is held in place by a pin, and the hole through the reamer is an easy fit, allowing some play, so that the reamer will adjust itself to the hole being reamed. The object of this arrangement is that if the reamer sticks, rather than to break the reamer, the spring will be closed up enough to permit the extending end to pass by the pin *C*, so as to leave the reamer stationary until the machine is stopped. MACHINIST.

AN EXTENSION PLANER TOOL HOLDER.

In the cut below is shown a tool of clapper box type designed for holding tools in the planer. *B* is the shank or holder. At *A* is shown a toothed clutch secured to the tool shank *B* and the tool-holder *D*, respectively. The holder is



held to the shank by means of a nut *C*. By loosening this nut and raising the tool-holder *D*, thus disengaging the clutch, the tool may be turned to almost any angle without throwing the head of the planer over. G. E. WHITE.

Newark, N. J.

REMOVING PULLEYS FROM SHAFTS.

When a pulley or collar sticks on a shaft and will not come off, sprinkle alcohol freely around the ends and tap lightly with a hammer, which aids the alcohol to reach the part cramped. This method will also work well when a bearing binds from lack of oil. WM. DAVIS.

Philadelphia, Pa.

SHOP RECEIPTS AND FORMULAS.

A DEPARTMENT FOR USEFUL MIXTURES.

This page is intended to be used only for the publication of such shop receipts as the contributors know from experience to be practicable. Receipts are solicited on the condition that the contributors personally know that they are reliable. The fact that a receipt is old and supposedly well-known does not bar it, provided it has not already appeared here.

351. ANNEALING STEEL.

Cover the steel with fire clay, and heat to a red heat. Then allow the steel to cool over night in a furnace or forge. This method will prove satisfactory when other means fail.

Rockford, Ill. SAMUEL H. OWENS.

352. COOLING COMPOUND FOR NECKS OF ROLLS AND SHAFTS.

Dissolve 2¼ pounds of lead acetate in 14 pounds hot tallow and add 2¼ pounds black antimony. Stir the ingredients constantly until cold. W. R. BOWERS.

Birmingham, England.

353. FIRE CLAY MIXTURE.

A fire clay mixture that will stand a high temperature without cracking or checking is mixed as follows: 45 per cent crushed fire brick, 50 per cent fire clay, and 5 per cent clean, sharp sand. This is to be moistened and mixed to a heavy paste, tamped into the shape required and burned dry.

Denver, Col. E. W. BOWEN.

354. STEAM TIGHT JOINTS.

Take white lead ground in oil, add to it as much black oxide of manganese as possible and a small portion of litharge. Knead with the hand, dusting the board with red lead. The mass is made into a small roll and screwed or pressed into position, the joint being first slightly oiled with linseed oil.

R. E. VERSE.

355. STROP PASTE FOR RAZORS AND KEEN EDGE TOOLS.

An excellent strop paste for edging razors or other keen-edge tools is a mixture of levigated oxide of tin, 1 ounce; powdered oxalic acid, ¼ ounce; powdered gum, 20 grains. Mix to a paste with water, spread evenly over, and work well into the strop with some smooth surface. The rough side of the strop gives best results. E. W. BOWEN.

Denver, Col.

356. METAL POLISH.

Get two or three oyster or clam shells and burn them on clear coal fire for fifteen or twenty minutes; then powder them in a mortar. This makes a superior metal polish. It is the best thing I have ever used for polishing silver and gold articles, and if finely pulverized can be used on the most delicate article without injury. REX MCKEE.

Joliet, Ill.

357. WASH FOR WHITENING METAL WORK FOR LAYING OUT.

Mix whiting and white lead with boiled linseed oil to a thick paste; add some Japan dryer, and thin with benzine or gasoline. This makes a fine preparation for whitening sheet iron and other work previous to laying out, as any lines drawn on the surface show up very distinctly. It also makes a very good stenciling or marking paint. A. D. KNAUEL.

Moline, Ill.

358. TO PREVENT GLUE CRACKING.

A useful fact to know in regard to glue when using it on furniture or other work that will be exposed to a very dry atmosphere, is that a small addition of chloride of lime will tend to prevent the glue drying out and cracking. The chloride of lime is strongly hygroscopic and constantly attracts enough moisture from the atmosphere to keep it moist. Use about one-fourth ounce of chloride to one quart of glue.

M. E. CANEK.

359. LUBRICANT FOR TURNING COPPER.

Having noticed that in the Shop Receipts in the March issue it is stated that milk is a good lubricant for use in turning copper, I would like to mention another which is perhaps more easily procurable, or rather more apt to be on hand, in a machine shop. This is gasoline. In our shop we have used gasoline as a lubricant for cutting copper with very good results. GEORGE C. NASH.

Rockford, Ill.

360. TO WATERPROOF LEATHER.

To waterproof leather and leave it soft and pliable, apply a mixture of 4 parts castor oil and 1 part raw india rubber, by weight. Heat the oil to 250 degrees F., then add the rubber, cut into small pieces. Gradually stir until the rubber is completely dissolved and then pour into a suitable vessel and let cool. If used on dark leather add sufficient printer's ink to give the dark color. E. W. NORTON.

361. LIQUID METAL POLISH.

A good liquid metal polish for cold smooth surfaces, either iron or brass, may be made from the following ingredients: To 3 quarts of benzine add 2 ounces of oxalic acid and 1½ pound of silicate acid powder. This polish may be made in large quantities and set aside for further use provided it is kept in tightly closed bottles, and shaken well before using. Apply the solution with a piece of cloth. When dry, polish with a soft, clean cloth. T. E. O'DONNELL.

Urbana, Ill.

362. CEMENT FOR FASTENING METALS TO GLASS.

Melt together in a water bath 15 parts of copal varnish, 5 parts of drying oil, and 3 parts of turpentine. When the ingredients are well mixed add 10 parts slacked lime. An elastic cement for fastening brass to glass may be made by mixing 5 ounces of resin, 1 ounce beeswax, and 1 ounce of red ochre or venetian red in powdered form. Melt the resin and beeswax together by gentle heat, and gradually stir in the venetian red. W. R. BOWERS.

Birmingham, England.

363. POLISH FOR BRASS.

An excellent liquid polish for articles of brass may be made as follows: Add together and mix thoroughly, 100 parts of powdered pumice stone, 2 parts oil of turpentine, 12 parts soft soap and 12 parts of fat oil or lard. When thoroughly mixed, add the mixture to a solution of 3 parts oxalic acid dissolved in 40 parts of hot water. Stir well until a uniform paste is formed. Apply to surface of any article of brass, by means of a cloth, rubbing it in well. Remove remnant and polish with a clean, dry cloth. T. E. O'DONNELL.

Urbana, Ill.

364. TO CASE-HARDEN FOR COLORS.

Mix 10 parts charred bone, 6 parts wood charcoal, 4 parts charred leather and 1 part of powdered cyanide potassium. Clean the work thoroughly, and do not handle with greasy hands. Pack the work with the mixture in a common gas pipe plugged at one end, and seal at the other with asbestos cement. Heat in a furnace to a dark cherry red and keep at that heat for about 4 or 5 hours. Dump in a tank with compressed air bubbling up through the bottom. If the colors are too gaudy leave out the cyanide. J. F. SALLOWS.

Grand Rapids, Mich.

365. PASTE METAL POLISH.

A paste metal polish that is good for any smooth surface, whether hot or cold, can be obtained from the following ingredients, which will make about 20 pounds of the polish: 2 ounces of spermaceti, 4 ounces of cake tallow, 10 star candles, 2½ pints of raw linseed oil, 2½ pints of kerosene, and 5 pounds of tripoli powder. Procure a crock that will hold 3 or 4 gallons. Put in the tallow, spermaceti and candles, and melt over a slow fire. Then add the linseed oil and kerosene, and stir well. While this mixture is still warm, remove from the fire, and add the tripoli powder very slowly while constantly stirring the mixture. When all the powder has been added, allow to cool. To use, apply with a soft cloth, and after drying, remove the remnant and rub the surface with a piece of soft flannel. T. E. O'DONNELL.

Urbana, Ill.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

MAKING GEARS TO BROKEN SAMPLES.

J. H.—Suppose I am given the task of making a gear of any kind, and am given a sample gear that is broken in several pieces, so that it would be impossible to caliper it or measure it in any other way. How can I get the exact dimensions by calculation to make a new gear? I want to know the outside diameter, pitch diameter, thickness of tooth, etc.

A.—If the broken gear is of an even diametral pitch the problem is a simple one. In the Brown & Sharpe catalogue will be found a series of silhouetted profiles of gear teeth, of various diametral pitches. These will be found in other books relating to gearing as well. A tooth of the broken gear may be matched up with these drawings until it is found what pitch the original gear was. Then add 2 to the number of teeth in the broken gear, and divide by the diametral pitch found. This will give the correct outside diameter. Divide the number of teeth by the diametral pitch, and the answer will be the pitch diameter of the gear. Divide 1.5708 by the diametral pitch, and the result will be the thickness of the tooth at the pitch line. Divide 2.1571 by the diametral pitch, and the result will be the total depth of the space, or the depth of cut required. All the dimensions thus obtained are in inches. For example, a broken 30 tooth gear is found by comparison with the catalogue cuts to be 4 diametral pitch. The outside diameter is then $(30 + 2) \div 4 = 8$ inches. The pitch diameter is $30 \div 4 = 7\frac{1}{2}$ inches. The thickness of tooth at pitch line is $1.5708 \div 4 = 0.3927$ inch. The whole depth of tooth is $2.1571 \div 4 = 0.5393$ inch.

QUESTIONS OF STRENGTH OF MATERIALS, ECCENTRIC LOADING.

A. W.—1. Fig. 1 represents a wrought-iron bar with an offset of 3¼ inches. This is a draw-bar between a locomotive and tender. Please tell me how to calculate the fiber stress in this piece. Of course, it would not stand as great a strain as it would if it were a plain straight bar of the same section. It is subject to a pull of 21,600 pounds. 2. The sketch, Fig. 2, shows a load suspended at the end of a boom, which is in turn suspended from the tie-rod or guy rope shown. What will be the strain in the boom and the guy rope if weight W weighs 5,000 pounds, and what formulas would be used in solving this?

A.—1. You are right in surmising that the fiber stress in the bar is greater when it is bent as shown than it would be if it were straight. This is because a bending strain is introduced in the offset portion. This bending strain may be expressed in inch-pounds by multiplying the load in pounds by the amount of offset in inches. Fig. 3 shows the principle. The stress in the offset portion of the bar is the same as if it were broken off, as shown, and the load were applied to a clamp or bracket, the point of application being in line with the original center line of the load. It is easy to see in this case that a bending moment of Px inch-pounds is set up, tending to bend and break the bar where it is fastened to the clamp. Considering the bar, then, as a beam subject to a bending moment of Px inch-pounds, we have for fiber stress

$$S = \frac{Mc}{I}$$

in which S is the unit fiber stress.

I is the moment of inertia of the section.

c is the distance from the netural axis of the section to the outermost fiber in the plane of bending.

The moment of inertia for a rectangular section equals the width multiplied by the cube of the height, divided by 12; or, $4 \times (2\frac{3}{8})^3 \div 12 = 4.46$.

$M = Px = 21{,}600 \times 3\frac{1}{4} = 70{,}200$ inch-pounds.

$$c = \frac{2\frac{3}{8}}{2} = 1.18, \text{ about.}$$

Inserting these in the formulas first given, we have

$$S = \frac{70{,}200 \times 1.18}{4.46} = 18{,}700 \text{ pounds per square inch.}$$

This is the unit tensile stress due to bending. Besides this we have that due to direct tension, which is found by dividing the load by the area of the section. This gives us

$$\frac{21{,}600}{4 \times 2\frac{3}{8}} = 2{,}270 \text{ pounds per square inch.}$$

The maximum fiber stress will then be equal to the sum of these two, or $18{,}700 + 2{,}270 = 20{,}970$ pounds per square inch. Another case

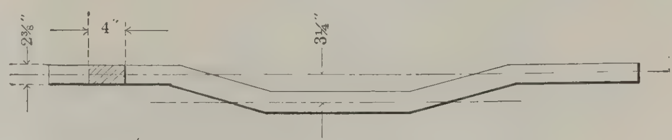


FIG. 1

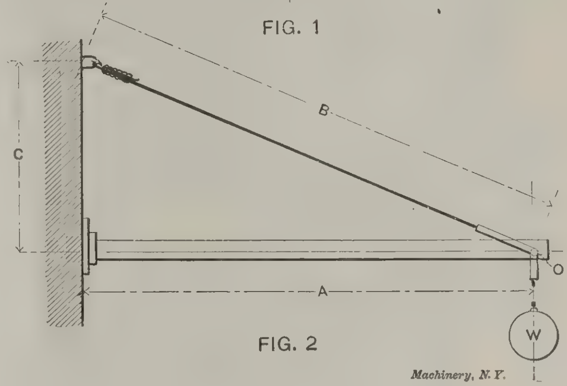


FIG. 2

Machinery, N.Y.

of the same kind is shown in Fig. 4. In this, or any other case, a straight line may be drawn between the two points where pressure is applied. If, then, the neutral axis be drawn, the point where the distance between the neutral axis and the pressure line is greatest will be the point where the bending moment is greatest. The distance between the lines at this point, shown by x in Fig. 4, will be the lever arm of the bending moment, which will be expressed as Px, the same as in Fig. 3.

2. This problem can be simply solved by the parallelogram of forces. Draw a diagram like that shown in Fig. 5 in

FIG. 3

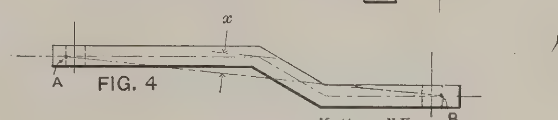


FIG. 4

Machinery, N.Y.

which F_1 is parallel to the pull of the weight (which, of course, is vertically downward), F_2 is parallel to the direction of the beam or compression member, and F_3 is parallel to the guy rope. Make F_1 of a length representing to scale the weight of the load. Complete the parallelogram determined by the length and position of F_1, and the directions of F_2 and F_3. F_2, measured to the same scale as F_1, will then give the compressive stress in the boom, while F_3 will give the tensile stress in the guy rope. Calling the side of the parallelogram

FIG. 5

Machinery, N.Y.

opposite F_1 by the symbol F'_1, and noting that F_1 and F'_1 are equal and parallel, it will be seen that the triangle enclosed between F'_1, F_2 and F_3 is similar to that included between the center lines of the guy rope and the boom, and the wall to which they are fastened. From this we may derive the following simple formulas in which

S_a = the compressive stress in the boom,

S_b = the tensile load on the guy rope or tie rod,

$$S_a = \frac{F_2\,W}{F'_1} = \frac{A\,W}{C} \qquad S_b = \frac{F_3\,W}{F'_1} = \frac{B\,W}{C}$$

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

BROWN & SHARPE NO. 4B PLAIN MILLING MACHINE.

The No. 4B heavy plain milling machine shown in the accompanying half-tones and line cuts is one of the latest pro-

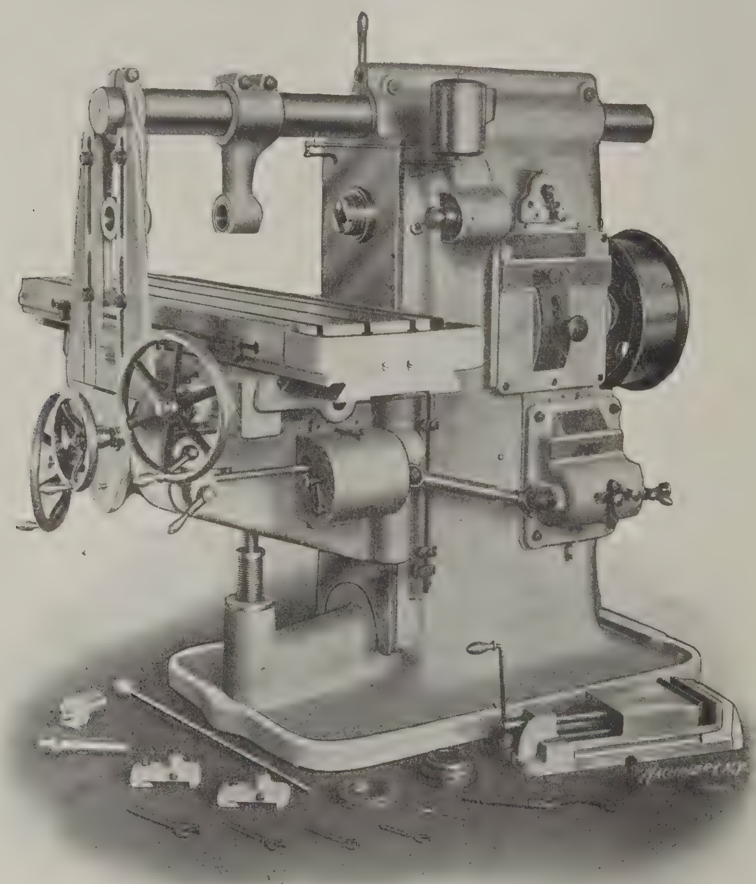


Fig. 1. Brown & Sharpe No. 4B Plain Milling Machine.

ducts of the Brown & Sharpe Mfg. Co., of Providence, R. I. It has the same feeding range, horizontally, vertically and across, as the older machine of the same number, but weighs much more, and has been built with a single pulley geared drive. The machine is, in fact, entirely new in all its parts, improvements having been made in every detail.

The advantages of the constant belt-speed drive for the milling machine, with the feed taken from the driving shaft, are too well understood to need elaboration. The line cut, Fig. 3, shows the mechanism used for changing the spindle speed on this machine. Driving pulley *A* is 18 inches in diameter for a 6-inch belt. It is very heavy and serves as a balance wheel to give steadiness of motion to the cutting spindle. It drives constant speed shaft *B* and driving pinion *C*. Gears *FFFF* rotate together on the shaft on which they are mounted. Either of these four gears may be connected with pinion *C* by an intermediate, not shown here, which is shifted longitudinally to match either of them and brought into mesh by the two knobs shown on the front side of the column in Fig. 1. A further change is obtained by a handle above them which rotates pinion *J*, shown in Fig. 3. This pinion meshes with circular rack teeth cut on the hub of double gear *H*. By this means, either the 31 or 47 tooth end of gear *H* may be engaged with the corresponding gears *FF* below it. Eight speeds are obtained by the mechanism shown. A further change is effected by what corresponds to the back gears of the ordinary milling machine. These are operated by a handle attached to an ordinary eccentric back-gear supporting shaft, which, however, is connected with a mechanism which automatically throws the main driving gear on the spindle out of mesh with the driving sleeve, a stopping of the machine and manipulation of lock bolt, etc., at this place not being required.

The rigid support of the spindle should be noticed. The upper part of the frame is entirely enclosed, making a stiff structure, and this rigidity is enhanced by the extension of the knee slide at the front of the column to the top of the machine. This extended knee slide also makes it possible to clamp any of the regular attachments directly to the face of the column in such a way that they become practically a part of the machine.

The spindle drive used is especially adapted to direct connection with a motor. Finished pads are provided on the machine so that the change may be made at any time without requiring any machine work to be done. Unless otherwise specified, the chain sprocket which replaces the driving pulley *A* in this case is connected to driving shaft *B* by a friction clutch, so that the machine may be started and stopped without recourse to the electric controlling mechanism. This scheme may also be used for the belt drive, in cases where it is desired to connect the machine direct with the line shaft without the intervention of a countershaft. Where it is desired to use a variable speed motor, the spindle driving gearing is much simpler than that shown, four changes only being obtained mechanically. The same total ratio of about 20 to 1 is still maintained in that case.

Other points of interest can be picked out from Figs. 3, 4 and 5, made from blue-prints kindly furnished by the makers. It will be noted that the table is very heavy and has great vertical depth, giving it unusual stiffness. The working surface has been greatly enlarged over the former machines of the same size. It has a quick return and slow speed longitudinal feed, operated by the same hand-wheel *O* in Fig. 5. The change is obtained by operating knob *N*, which is attached to clutch *P* as shown.

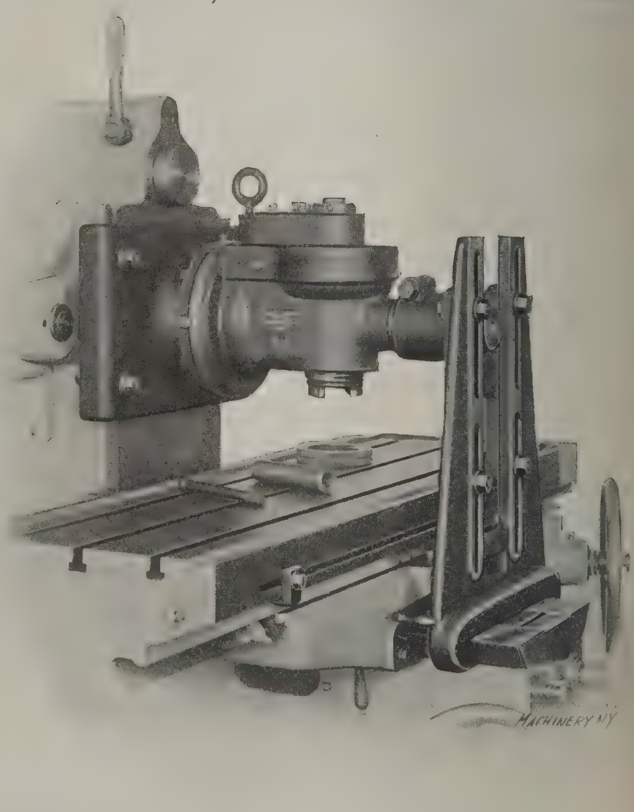


Fig. 2. Vertical Attachment for New Design of Milling Machine.

The hand-wheels for the three adjustments are all permanently attached to the machine and can be operated together

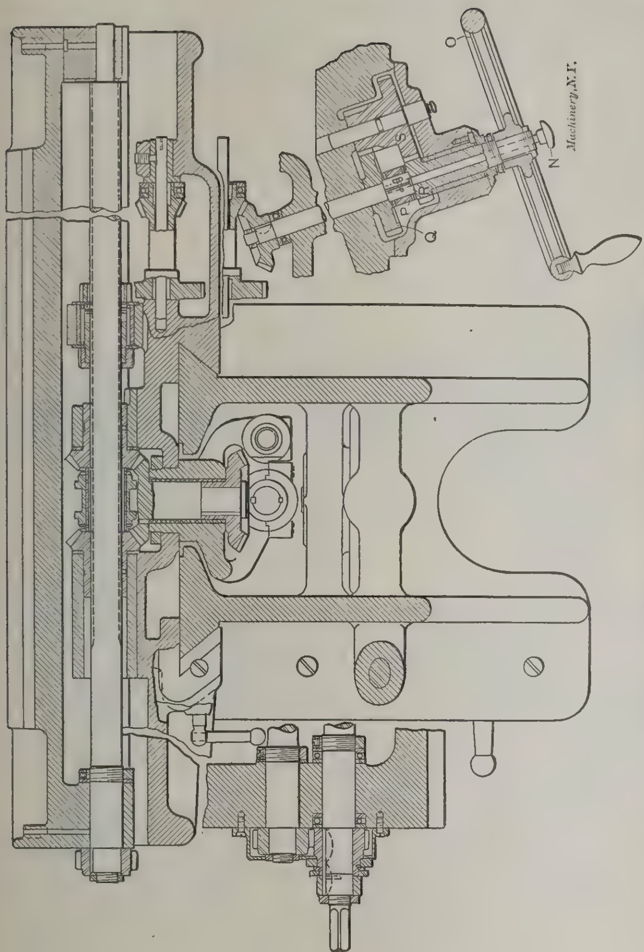


Fig. 5. Details of Table Feed and Hand-wheel Gearing.

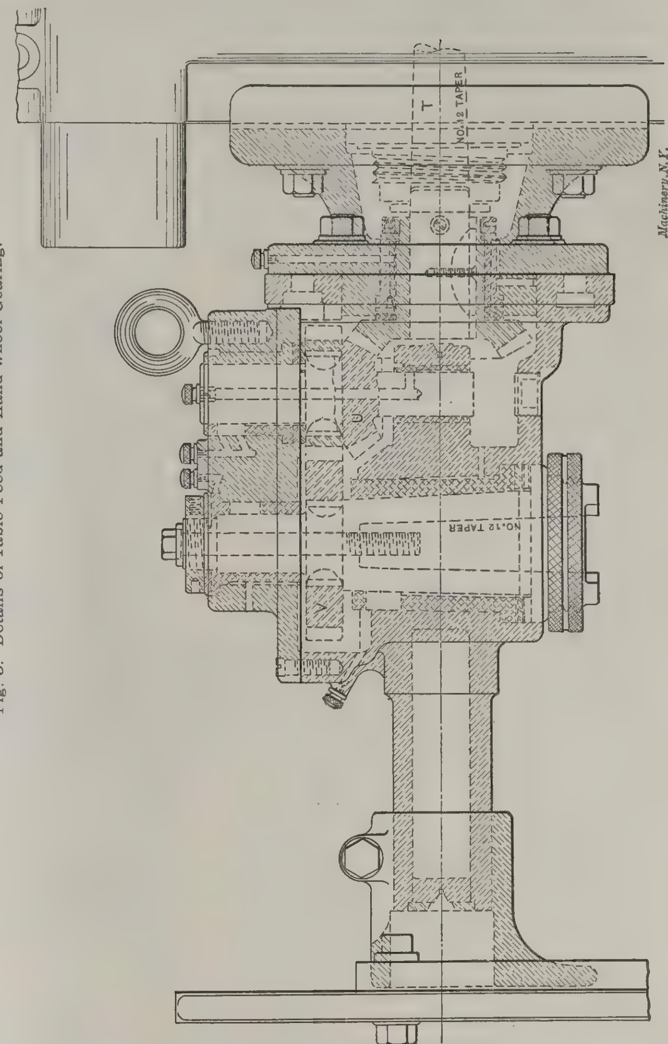


Fig. 6. Mechanism of Vertical Milling Attachment shown in Fig. 2.

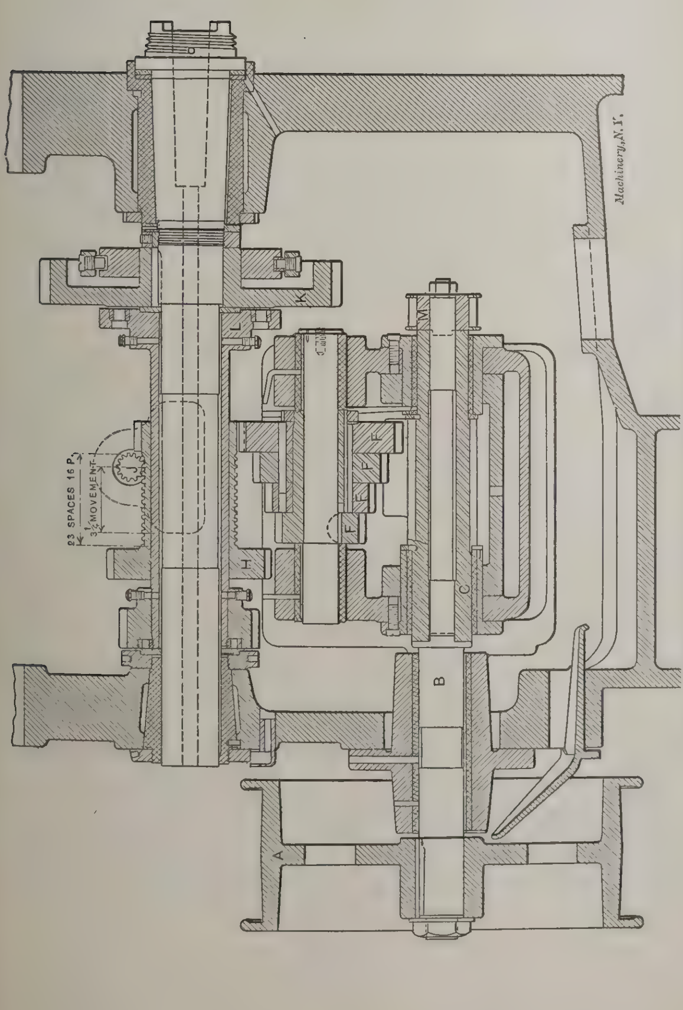


Fig. 3. Vertical Section through Spindle and Driving Gears.

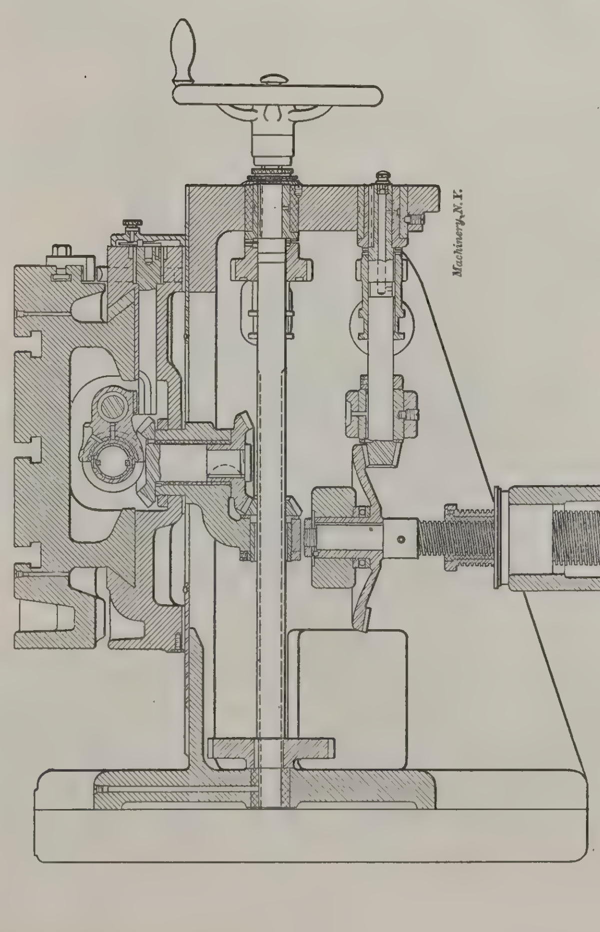


Fig. 4. Vertical Section through Knee and Table

without interference. They are all provided with throw-out clutches to disengage them after the adjustment is made, and all have dials graduated to read to 0.001 inch.

Sixteen changes of feed are obtained by the quick change gear mechanism supplied with the machine. The drive is by spur gears entirely, connected with the constant speed shaft of the driving pulley. An automatic tripping mechanism is supplied for all three feeds. When desired, the machine may be simplified by having only the longitudinal feed automatic. Suitable oil pans and channels are provided. When an oil pump is furnished, provision is made to carry the oil into the saddle and then to the tank, thus doing away with the long piping necessary to follow the movement of the table.

The machine shown has a longitudinal feed of 42 inches, a cross feed of 12 inches, and a vertical feed of 20 inches. The table working surface is 57¾ inches by 19 inches with three ¾-inch T-slots. The net weight of the machine is approximately 8,200 pounds.

The vertical attachment for this machine is shown in the halftone, Fig. 2, and the line cut, Fig. 6. It is proportioned to carry any cut within the pulling capacity of the main driving belt. Attention is called to the arrangement of the driving gears, which allows an unusual amount of spindle bearing, almost as large as that employed for the main spindle of the machine, thus insuring rigidity under the most severe service. The drive is from the main spindle of the machine by a clutch arbor *T*, through bevel gears to intermediate gear shaft *U*, then to spur gear *V* on the vertical spindle. This spindle has the same size taper hole and is threaded to the same diameter as the machine spindle. This allows the use of the same size collet chucks, face mills, etc., on either the machine or attachment spindle. All bearings are bushed with bronze and all gears are of steel, hardened and proportioned to transmit the full power of the main driving belt. The frame of the attachment is clamped directly to the face of the knee slide, and has an outer support to insure additional rigidity. It may be adjusted to any angle in a vertical plane. It weighs about 500 pounds.

DALLETT MOTOR-DRIVEN BOILER SHELL DRILL.

This machine consists, as shown in Fig. 2, of two end housings, on whose front face, carried by brackets, are two 5-inch bars supporting two independent motor driven drill heads, adjustable lengthwise on the bars. The brackets carrying the bars and the drill heads have a vertical adjustment of 6 feet. They are raised and lowered by means of screws actuated by a motor on the top rail of the machine. The machine is used in the usual way for drilling the rivet holes in boiler shells, the work being mounted on rolling supports in front of the drill spindles, which are adjusted to the proper vertical height. By rolling the shell and shifting the spindles longitudinally, any point in the bearing surface of the boiler may be reached. The machine is designed for the special purpose of taking advantage of the possibilities of high speed steel.

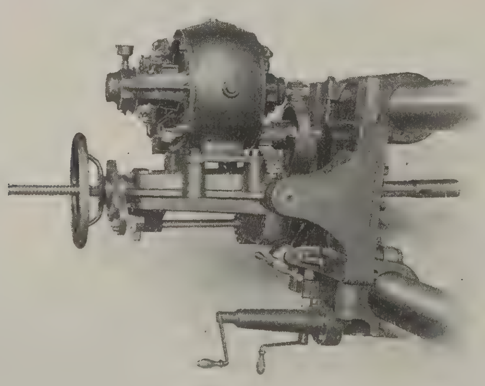


Fig. 1. Spindle Driving Mechanism of Dallett Drill.

Fig. 1 shows the design of the drill heads to the best advantage. Each is mounted on trunnions, and has a vertical adjustment in itself of 6 inches, operated by a crank handle at the bottom. It is moved on the bars by a rack and pinion on the under side of the lower bar. The variable speed motor is connected to the drill spindle by spur gears entirely, and gives a range of from 80 to 160 revolutions per minute. The spindle is bored for a No. 4 Morse taper. It has a traverse of 18 inches, and an angular adjustment on the trunnions of 15 degrees, to permit drilling rivet holes radially to the center of the boiler when the heads are not raised exactly to the proper height. This angular adjustment is controlled by the hand-wheel shown immediately beneath the driving gears. An especially valuable feature of the machine is the central position of the spindle, not only between the bearings of the drill head and the bars, but also between the bars themselves, so that the pressure of the drill against the work has no tendency to set up sidewise strains in the bearings of the drill heads or brackets.

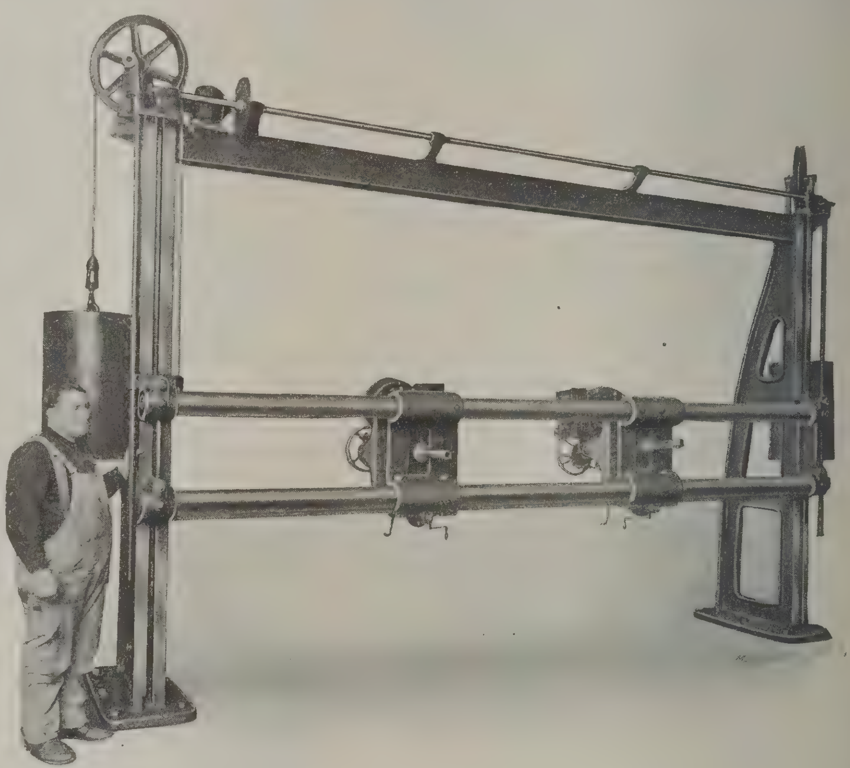


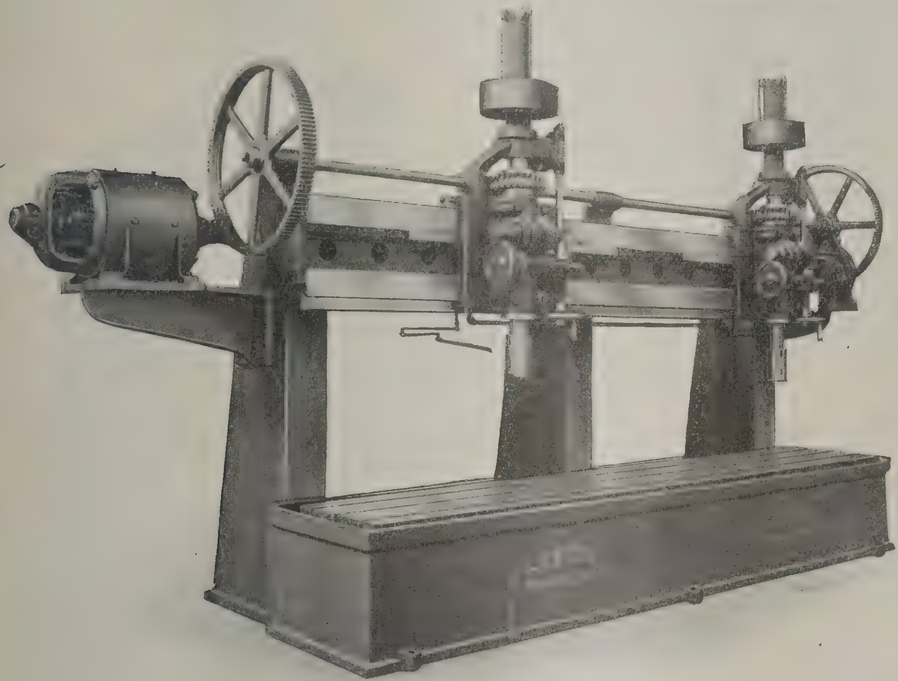
Fig. 2. Dallett Motor-driven Drill for Rivet Holes in Boiler Shells.

The feeding mechanism is of the ratchet type, adjustable to give from 0.005 to 1/16 inch per revolution. This range of feeds covers entirely the requirements for drilling in boiler work. The connecting rod between the adjustable crank and the rocker plate is fitted with a spring which can be set for any pressure of feed. It is impossible for this pressure to be exceeded, as the spring compresses when the limit is reached, and the feed ceases to operate until the pressure is reduced, thus providing an automatic release in the case of overloading the drill.

The machine is entirely self-contained, all adjustments being obtained by crank handles, no wrenches being required. The operator has all the adjustments of the drill head at his command at either side, without moving from his position. In the lowest position of the carriage, the center line of the spindles is 21 inches from the floor, and in its highest position 7 feet 6 inches. The distance between the housings is 14 feet, and the distance between spindle centers when the drill heads are in their outer position is 12 feet. The total weight of the machine is 12,000 pounds. The machine is built by the Thos. H. Dallett Co., 23d and York Sts., Philadelphia, Pa.

DOUBLE SPINDLE ROD BORING MACHINE.

The Newton Machine Tool Works, Inc., of Philadelphia, Pa., has recently furnished the Altoona shops of the Pennsylvania R. R. with the new design of double spindle boring machine which is shown in the accompanying half-tone. This machine is designed for finishing parallel rods and similar parts occurring in the manufacture and repair of locomotives. An interesting feature of the tool is the method by which the spindles are driven. There are two spindles, and a motor is provided for each. These motors, mounted on brackets bolted to the columns at either end of the machine, are geared with a large reduction to splined driving shafts, on which are mounted the worms which drive the worm gears on the spindles. A casual glance at the cut would give the idea that the driving shaft above the cross rail of the machine is a continuous one; but each half of it is in reality separate, the two ends having a common bearing in the central bearing support. The motors are furnished by the General Electric Co. They are of 7½ horse-power, and have a speed range of from 500 to 1,500 revolutions per minute.



Double Spindle Boring Machine for Parallel Rods, Etc.

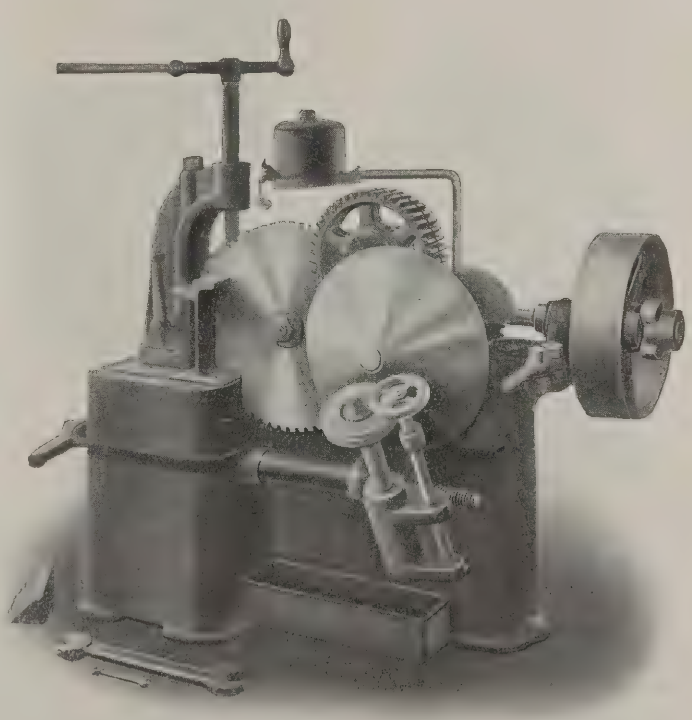
The cross rail is supported on three columns, as shown. It is of the hollow box type and serves as a reservoir for the lubricant used. The work table is 24 inches wide and 13 feet 6 inches long over the working surface, and is entirely surrounded by an oil channel. The two saddles are gibbed to the rail with brass taper shoes. They have a horizontal hand adjustment, permitting a range of from 4 feet between centers of spindles, to a maximum distance of 11 feet 9 inches. The distance from the bottom of the spindle to the top of the work table is 26 inches at its maximum. The driving worm-wheels are of bronze, meshing with hardened steel worms of steep pitch. As is clearly shown in the illustration, the feed is taken directly from each spindle by means of spiral gears, making the feed dependent on the motion of the spindle to which it is attached. This, with the separate drive provided for the two heads, permits the selection of the proper speed and feed for each tool independently of the other. The spindles are counterbalanced and four geared feed changes are provided.

QUINCY, MANCHESTER, SARGENT CO.'S METAL SAWING MACHINE.

The cut shows a new type of metal saw which has been recently added to the line built by the Quincy, Manchester, Sargent Co., of 90 West Street, New York. It is designed to meet a demand for a somewhat smaller machine than those of the standard line, which will yet exhibit all the strength and wearing qualities of the regular construction at a price within the reach of small shops, whose work does not warrant the expense of the heavier and more elaborate machine. The size shown is especially desirable for shops that have a large amount of round and square shapes to cut.

The saw blade is similar to that used on the "Bryant" type of machine, built by the same makers, being driven from its periphery rather than from the arbor. Instead of having a sprocket drive, however, steel rollers are used. These are hardened and ground and journaled in removable steel bushings which are held securely in the double driving gear which spans the saw blade, as shown in the cut. These rollers reduce the friction of the drive, and make repairs less expensive as well, since a roller can be easily replaced when it is worn or broken. The driving gear with its driving rolls can be adjusted toward or away from the center of the saw to give the right amount of back lash and proper action. By this method of drive, a much larger diameter of blade is available for cutting than can be obtained from one of the same size, arbor driven, in which case about one-third of the diameter is necessarily occupied by the driving collars.

The saw is carried on a tool steel arbor hardened and ground to standard size. The bearings of the saw arbor and all other shafts are either bronze bushed or babbitted. The carriage in which the saw arbor is mounted has the gib located on top of the ways on which it slides, so that no strain comes upon it other than that of keeping the carriage in position. This arrangement, which is similar to that used on the connection between the saddle and rail on a planer, makes the machine very rigid and free from vibration.



Quincy, Manchester, Sargent Co.'s Metal Sawing Machine.

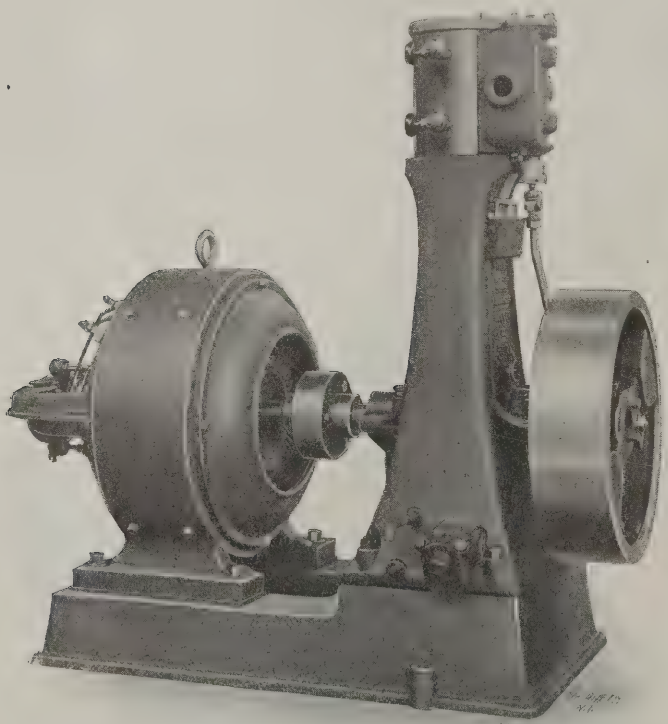
The feed is of the friction type, instantly adjustable, while the machine is in motion, to give from 3-16 to 1 inch per minute movement. It is greatly superior to a ratchet feed, which is necessarily intermittent in its action. The wheel shaft has a hardened worm and is supported in roller bearings. It meshes in a bronze worm-gear threaded to receive

the feed screw, which is held stationary when feeding by a latch pin, the worm-gear acting as a nut. To return the carriage, the latch pin is raised, and the handle attached to the feed screw operated by hand. This feed arrangement adds greatly to the simplicity of the machine and its consequent ease of operation, as well as being inexpensive.

The front table is of sufficient size to enable beams and channels to be properly held when being cut off at any angle up to 45 degrees. The holding device and driving power of the machine have a capacity for round stock up to 6 inches in diameter, square stock 6 inches on the side, and I-beams up to 10 inches in vertical dimensions. The driving pulley, which runs at a normal speed of 130 revolutions per minute, is 16 inches in diameter for a 3½-inch belt. The saw blade is 18 inches in diameter and 3-16 inch thick. The machine is furnished complete with two saw blades; special gages to cut duplicate parts; V-blocks of suitable size to center the largest diameter stock the machine is listed to cut; a clamp bracket large enough to hold any material up to the capacity of the machine; and the necessary wrenches. When desired the machine will be furnished arranged for direct-connected motor drive. The weight of the machine, mounted on skids for shipment, is approximately 1,500 pounds.

STEAM ENGINE GENERATOR SET FOR SMALL INSTALLATION.

The Robbins & Myers Co., of Springfield, Ohio, has brought out, in conjunction with the American Blower Co., the direct-connected steam engine generator shown in the accompanying cut. The engine was described in the February, 1905, issue of MACHINERY. As there stated, special pains have been taken to make the machine take care of itself, especially as relates to oiling and adjustment. A rotary pump, shown at the front of the base of the machine in the cut, is used to provide a steady



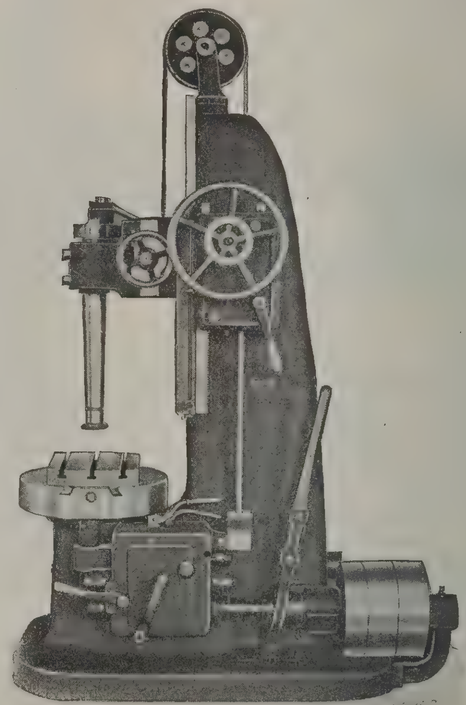
Robbins & Myers Generator for Direct-connected Service.

and sufficient supply of oil for all the parts requiring it. Tests in actual practice have proven that the engine will run several months without oiling or adjustment. The engine has a shaft governor, as shown.

The generator is one of the builders' protected type of machines of the line known as the "Standard." For use with the outfit shown, it is made in three sizes, 5, 6 and 8 kilowatt capacity each.

SAXON VERTICAL CYLINDER GRINDER.

The vertical cylinder grinder shown in the cut is built by the Saxon Machine Co., of Holyoke, Mass. It is designed for internal grinding gas and gasoline engine cylinders, air compressor cylinders, etc., and other holes which must be true, carefully aligned, and accurately finished. It is also convenient for external grinding of pins, bushings, pistons and similar work. It is built on the lines of the boring mill. The advantages of grinding cylinders in a machine of this type, instead of finishing them by boring, are that there is no springing of the tool away from hard spots or digging in at soft places; thin cylinder walls are not distorted, and there is no deflection of the tools in passing the port holes; duplex cylin-



Saxon Vertical Cylinder Grinder.

ders can be ground without resetting, thus insuring close alignment; and there is less danger of scoring when working in the cylinder with the piston.

The column is heavy and stiff, even beyond what would seem to be actually required. The bearing surface of the cross rail and face-plate are unusually large. The grinding head is adjusted for diameter on the cross rail by a screw having a dial graduated to thousandths of an inch. The vertical travel of the head up and down is automatic, being controlled by reversing dogs. There are six different feeds for each speed of rotation, varying from 1/32 to 5/16 inch per revolution. The wheel spindle is driven from a vertical shaft beside the grinder, and its bearings are of a special metal, adjustable and protected from dust.

The face-plate has large bearing surfaces, thoroughly safeguarded from emery. It is provided with two sets of three T-slots each, crossing each other at right angles. A special form of table (shown in the cut) may be used for duplex cylinders. This permits the work to be adjusted from one bore to the other without loosening it from its settings. The table has eight speeds, ranging from 7 to 41 revolutions per minute. The driving shaft is fitted with tight and loose pulleys, and is driven directly from the main line. No countershaft is required. A motor can be directly connected to the grinder when desired.

The machine will grind internal work up to 13 inches in diameter by 18 inches long, and external work up to 6 inches in diameter by 18 inches long. The grinding wheel ordinarily used is 3½ inches in diameter. The face-plate is 20 inches in diameter. The net weight of the machine is about 3,250 pounds. Attachments for the use of water and an exhaust fan for removal of the dust (not included in the regular equipment) will be furnished when desired.

TOLEDO PRESSES AND DIES FOR THE MANUFACTURE OF BATH TUBS.

This article describes an unusual and interesting outfit of machinery and tools, furnished by The Toledo Machine & Tool

Co., of Toledo, Ohio, for producing seamless stamped steel bath tubs. This outfit represents what is believed by its builders to be the largest set of tools yet furnished in this country for producing deep drawn work by the toggle press method. The work is done cold and is completed in only three operations, in such fashion as to avoid all wrinkling and distortion of the finished product. The stamping is an-

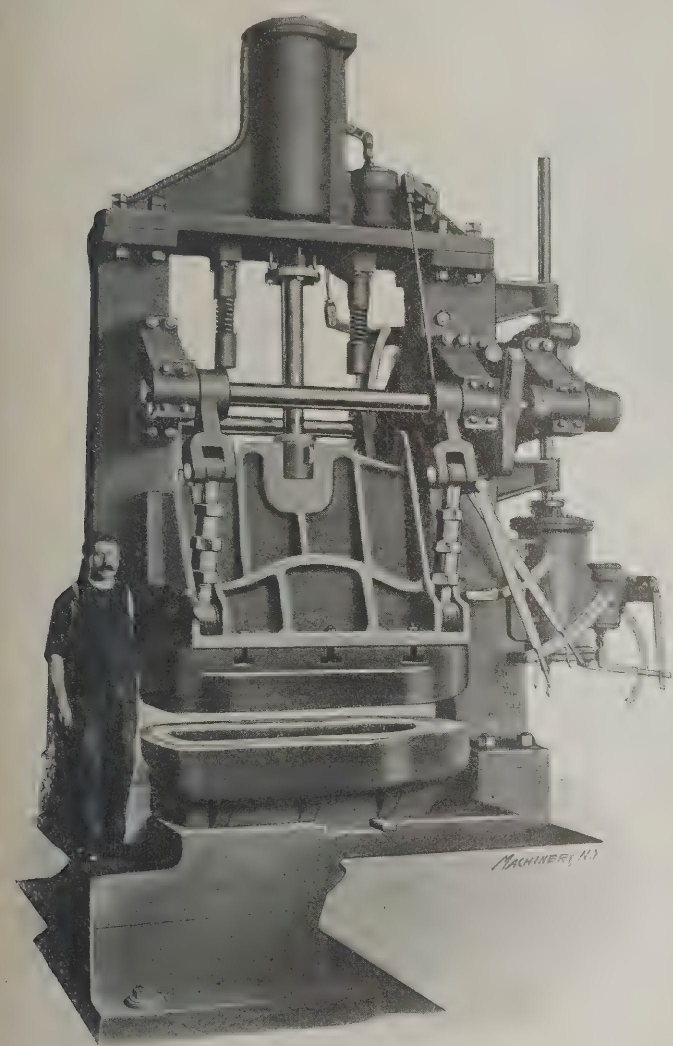


Fig. 1. Steam Actuated Toggle Press for Heavy Stamping and Forming.

nealed but once during the course of manufacture, and this annealing is required only to restore ductility to the rim, to prevent the possibility of fracture when trimming and forming in the third operation.

The press shown in Fig. 1 is the first machine employed. While it is very large and heavy, owing to its special design it is of much less weight than would be required with the usual form of toggle drawing press for small work of a

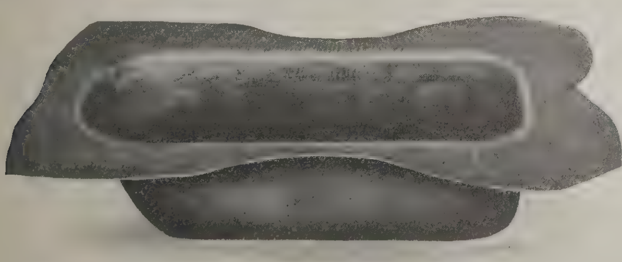


Fig. 2. Work at the Conclusion of the Second Operation.

similar nature. The movements are controlled by two direct-connected steam cylinders, one for the holding die, and the other for the forming plunger. The first of these is the smaller one, located at the right hand side of the machine. Its pistons are connected by links with two rocker shafts, one at the front and the other at the rear of the machine. These rocker shafts carry arms to which are pivoted connecting rods, attached to the blank holder. This mechanism forms a series of four toggle joints, one at each corner of the blank holder. The lever, controlling the valve of this small cylinder, enables the operator to elevate or lower the blank holder, and securely lock it on the stock at pleasure, independent of other movements of the machine. The blank holder has a vertical movement of 19 inches, and the pressure which it is possible to exert through it on the blank is estimated to be approximately 1,400 tons.

The main cylinder for operating the forming plunger is mounted on the yoke connecting the two side housings, at the top of the machine. It is 28 inches in diameter and gives a stroke of 50 inches. Its piston rod is attached to a steel cross head or ram weighing about 6,000 pounds, and this, with the male forming die which is attached to it, gives a falling weight

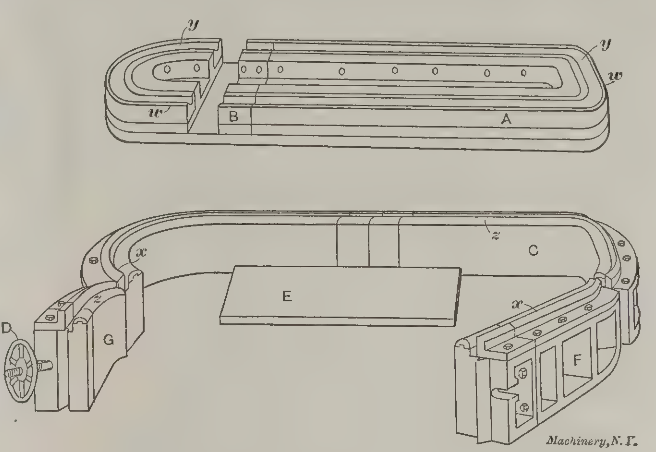


Fig. 3. Dies used for Trimming and Rolling the Rim.

of about 20,000 pounds. The base or anvil of the machine is made in three sections, the combined weight of which is about 90,000 pounds. The main arch and cylinder and the two housings or uprights are securely bolted together on the anvil, and reinforced by four large tie-rods passing through from top to bottom and shrunk in position.

The dies used for drawing the stock consist of a female die made adjustable for three sizes or lengths, and a forming punch for each die, which is keyed to the cross head or ram. Besides this there is a pressure plate for each size, securely bolted to the blank holder. The operator places a plain squared sheet or plate of steel, ⅛ inch thick, in position in the die, and brings the clamping mechanism into operation, forcing the blank holder and pressure plate down on the

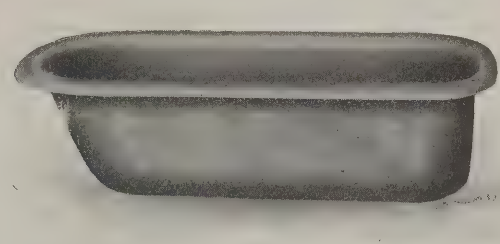


Fig. 4. The Tub after the Third and Last Operation.

sheet, where it remains at rest, automatically locked. Next, the larger cylinder is brought into operation, forcing the plunger onto the sheet and forming the stamping to a depth of about 12½ inches. This completes the first operation. It requires about 40 seconds to place the work in the machine, 40 seconds to do the work, and about the same length of time to remove the stamping. After being annealed and pickled to remove the scale, the work is again placed in position in the machine, which has been fitted meanwhile with the second operation dies. Here, in a similar manner, the forming of the stamping to a depth of 17½ inches is completed. The work now has the form shown in Fig. 2.

The stampings are then ready for the trimming process, where the flange is trimmed and the curved rim formed. Here two operations are completed at one stroke of the machine. This machine is similar in design to the one made by the same

firm and illustrated in the new tools column of the March, 1907, issue of MACHINERY. The machine is, however, considerably larger and heavier to fit it for this particular work. The dies used are illustrated in Fig. 3. The plunger, shown inverted at *A*, is provided with two filling pieces, one of which, *B*, is in place in the cut, while the space in which the other fits is shown alongside of it. These filling pieces allow the punch to be altered for different lengths of tubs, three sizes being made with this set of tools. The die is shown at *C*. This also has filling pieces on either side to adjust its length to that of the punch. The front side is hinged at either end, so that it may be opened up to facilitate the removal and insertion of the work.

The stamping, in the condition shown in Fig. 2, is placed in the die *C* in Fig. 3, which is thereupon closed and locked by hand-wheel *D*. Plunger *A* now descends. The outside cutting edge of the plunger at *w* strikes the blank all around, shearing it off against the cutting edge *x* in the die. The continued downward movement of *A* rounds the rim thus left between semi-circular groove *y* in the plunger, and the rounded top *z* of the die. On the upward stroke, the work adheres to the plunger and is carried up with it until it is released by a positively-operated knock-out, when it falls back into the die. Lower knock-out *E*, which has meantime been raised from the bed of the press, prevents it sticking in the lower die, and makes removal easy. The tub, finished, so far as the forming is concerned, is shown in Fig. 4.

The machines herein described are of unusual size, and represent quite an achievement in the way of heavy forming without recourse to the hydraulic press. A few figures will give some idea of the capacity and weight of the machine shown in Fig. 1. The width between the housings is 96 inches, the area of the bed is 96 inches right to left, by 60 inches front to back. The total height of the machine from the bottom of the bed to the top of the cylinder is 23 feet, and the net weight is 260,000 pounds.

EBERHARDT BROS. NO. 5 AUTOMATIC GEAR CUTTER.

The two halftones shown herewith illustrate an automatic gear cutting machine for spur gears, built by Eberhardt Bros. Machine Co., 66 Union Street, Newark, N. J. This machine, which is the largest of the line so far developed by this firm, is a heavy, strongly driven tool of simple construction, involving a number of features of unusual interest.

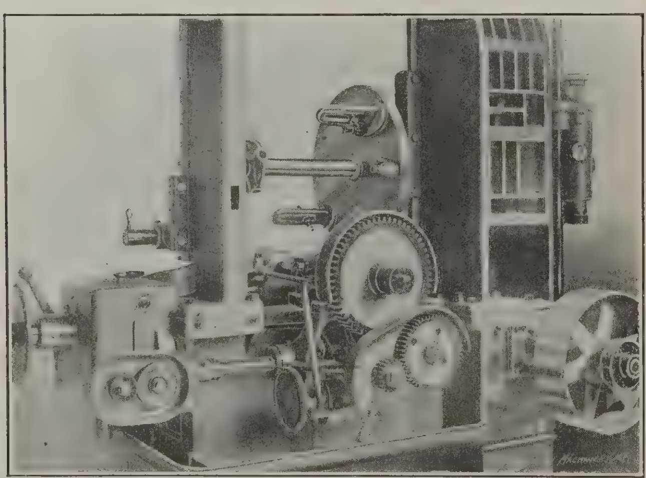


Fig. 1. Eberhardt Automatic Gear Cutter, Rear View.

At full swing, a gear 60 inches in diameter and of a face width up to 16 inches can be handled, 2½ diametral pitch in steel, or 2 in cast iron. The unusual width of face provided for is allowed by the long cutter slide construction and the arrangement of the frame which allows the cutter to come up close to the column. The spindle bearing is in the center of the slide, and the thrust bearing of the feed screw is so located that it is always under tension, whether feeding or returning the slide. The slide is thus drawn and not pushed. Another new feature of the feed gearing is the provision for a change in the ratio obtained by a sliding gear moved by a handle. With any pair of gears in place two feeds can thus be obtained. The change is so arranged that one feed is suitable for the first cut and the other for the finishing cut, when using a finishing cutter and one or more roughing cutters in a gang. The feed changes are arranged in geometrical progression, giving from ¾ to 15 inches per minute. As the cutter speeds range from 20 to 128 revolutions per minute, the new feed arrangement allows the use of high speed cutters to advantage, inasmuch as fast feeds can be used, which it would be difficult to obtain in the usual manner.

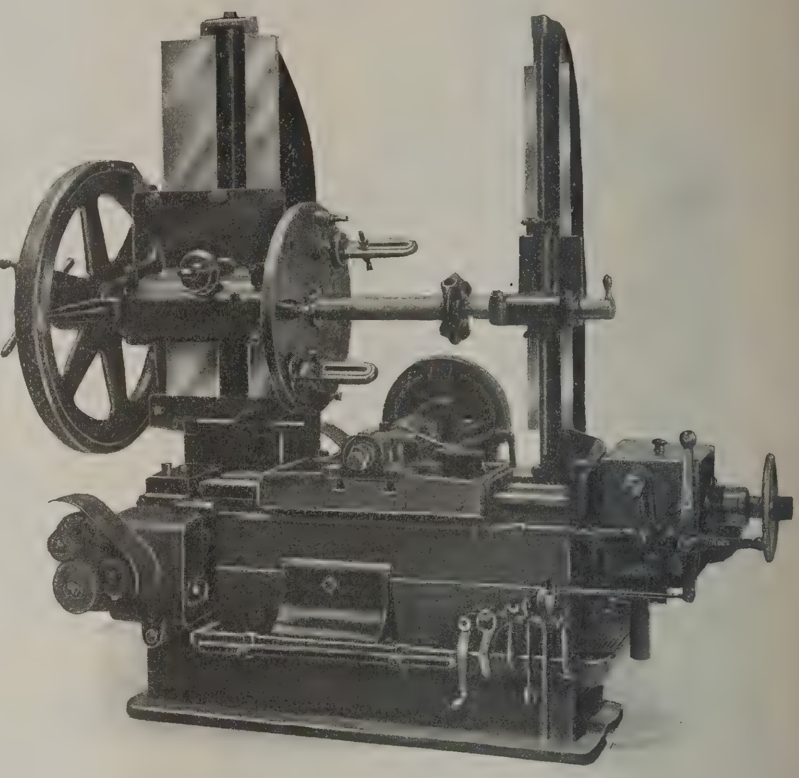


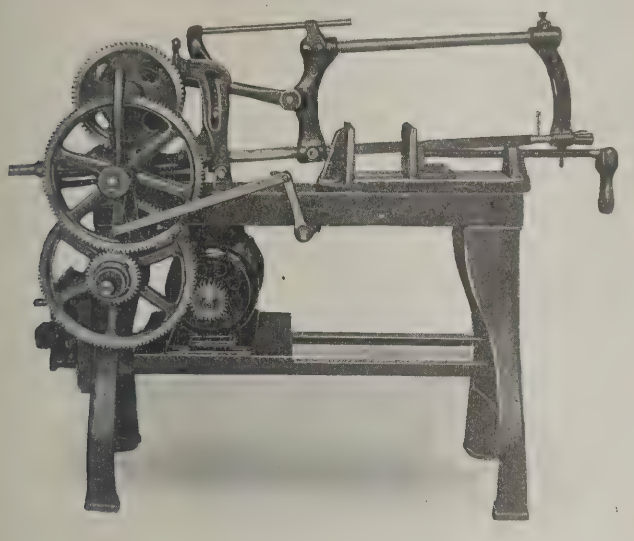
Fig. 2. Eberhardt Bros. No. 5 Automatic Gear Cutter for Spur Gears.

The index wheel is of large diameter, made in two sections. It is hobbed in place, and by successive settings and cuttings the wheel is made of the highest accuracy possible. The indexing mechanism is positive, employing a locking disk operated by a positive clutch. The disk makes one or more full turns and is locked in position at the end of each indexing without depending on the momentum. When the indexing is in progress, the feeding is automatically locked, so that the cutter slide cannot move until the division is completed. The feed is also interlocked with the indexing mechanism, so that it cannot index while the slide is feeding. The levers for engaging and disengaging the feed and for indexing by hand are placed on the operating side of the machine to facilitate the setting.

The cutter spindle is set in the center of the cutter slide bearing. It is made from a hammered tool steel forging, and is driven, as shown in Fig. 1, by spur gearing through change gears from the driving shaft. The spur gear gives the most efficient transmission of any form of gearing, and is especially advantageous for the high spindle speeds used with high speed steel cutters, where a worm would waste considerable power and tend to wear out. A good test of the drive and feed mechanism was shown in the cutting of teeth of three diametral pitch in 30 point carbon steel, 5 inches face, from the solid, using a roughing and finishing cutter side by side. The feed was 4½ inches per minute. These cutters were, of course, regular carbon steel cutters, and the feed and speed could have been increased had they been of high speed steel.

ROBERTSON NO. 3 MOTOR-DRIVEN HACK-SAW.

The Robertson Mfg. Co., of Buffalo, N. Y., makes a specialty of the manufacture of power hack-saws, which it furnishes in various styles and sizes to suit the needs of customers. The machine shown in the accompanying cut is motor driven, and has a positive geared connection between the armature

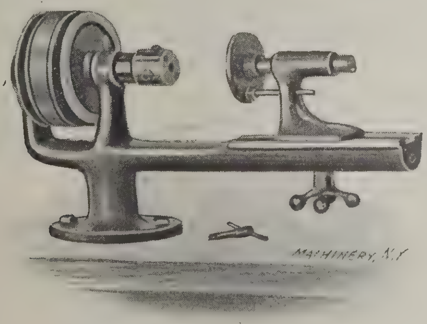


Robertson No. 3 Motor-driven Hack-saw.

shaft and the crankshaft. The motor is mounted on brackets supported on the legs at the rear end of the bed. The pinions are of fiber, bushed with metal. The motor is furnished for direct or alternating currents, and is ¼ horse-power in size. The machine shown has the builder's adjustable frame, which provides for using short blades on small work. The complete line of which this machine is a member, consists of eight sizes, with a maximum capacity of 4 x 4 for the smallest and 12 x 17 inches for the largest.

CHAMPION TAPPING MACHINE.

This tool is designed for tapping small holes in light work, either through or to depth. It has two friction pulleys, driven from the countershaft by open and cross belts so that they revolve in opposite directions. These spindles are mounted on self-oiling bronze bearings, independent of the spindle of the machine, which may thus be made light and left very sensitive. The work is held against a plate in the adjustable tail-stock, while the tap is held in a chuck in the end of the spindle. The spindle carries a friction, which may be made to engage with either of the two driving pulleys. The work,



Machine for Light Tapping, made by Blair Tool & Machine Works.

held against the plate on the tail-stock spindle, is brought up against the tap and fed in toward it lightly, a slight pressure giving the necessary power, through the friction, for driving the tap in the forward direction. At a predetermined depth the movement of the tail-stock spindle is arrested by an adjustable stop. As the tap continues to screw into the work, it is then drawn in toward it, thus releasing the forward driving friction, whereupon the tap comes to a standstill. The work is now dropped back, bringing the tap and spindle with it, and engaging the friction of the backing out pulley, thus screwing the tap out of the work. This arrangement makes a very quickly-operated machine and one in which the breakage of even the smallest taps is reduced to a minimum. Holes up to ¼ inch in diameter may be threaded. This machine is manufactured by the Blair Tool & Machine Works, 24, 25, 26 and 27 West Street, New York.

ADDITIONS TO THE BROWN & SHARPE LINE OF SMALL TOOLS.

The Brown & Sharpe Mfg. Co., Providence, R. I., has recently made a number of additions to its line of small tools for machinists and tool-makers. We describe herewith a number of the most interesting of these.

One of the new tools, a pocket scriber, is a neat and inexpensive instrument, intended for carrying in the pocket. For this purpose it is provided with a removable point, which is held in the handle by a 4-jawed chuck operated by the knurled nut at the lower end of the body. When not in use, this point is reversed so that there is no danger of piercing the clothing or injuring the operator, if it is carried carelessly. The scribing point is carefully tempered. The handle is knurled for a finger grip and is provided with a hexagonal head to prevent rolling when it is laid on the bench. The tool is about 3½ inches long when reversed for carrying.

In Fig. 1 is shown an attachment intended for use with the maker's well-known automatic center punch. As shown, the attachment is screwed onto the center punch in place of the removable point. When so arranged, it will be found useful in quickly and accurately laying out holes in circles. The fine adjustment of the locating point is obtained by the screw at the end, and the quick adjustment, by pulling out the knob at the top of the post. The point is held by a knurled check nut, and it can be adjusted to suit varying lengths.

A smaller size of the well-known automatic center punch has been brought out. This is

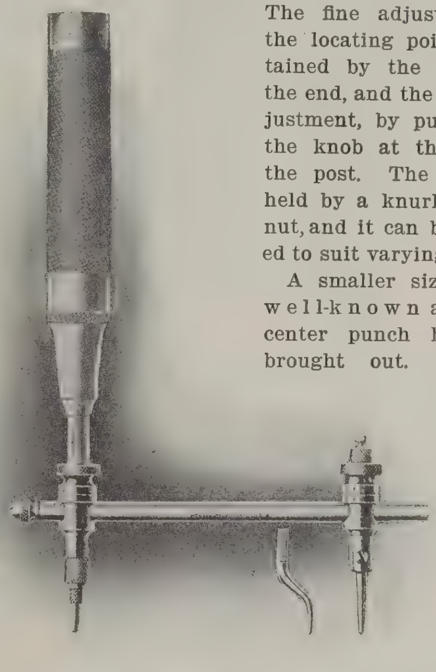


Fig. 1. Spacing Attachment for Automatic Center Punch.

made to meet the demand for a small, light tool, suitable for the delicate work required in tool-making. It operates in the usual manner, a downward pressure on the head releasing the striking block and making the impression. The striking mechanism is adjusted to give a quick and uniform punch mark. The tool is constructed of steel throughout, hardened and tempered wherever subject to wear, and nicely finished. It is 4⅛ inches long over all, and ⅜ inch in diameter.

A novel combination caliper and divider set is made, comprising a pair of legs carrying chucks at the lower ends, in which may be inserted and held auxiliary legs of various shapes. The tool may thus be used for dividers, outside or inside calipers, or a combination of outside and inside. A pencil can be substituted for one of the legs if desired, thus making the tool useful as a compass. The instrument is of steel throughout, carefully finished, with sharp corners eliminated. When used as a divider, it will describe a circle 21½ inches in diameter.

A set of steel rules with a holder provided for them, as shown in Fig. 2, will be found convenient where ordinary rules cannot be used, as in measuring in grooves, recesses, keyways, etc., or other inaccessible places in general tool and die work. Five sizes of rules or scales are provided, ¼, ⅜, ½, ¾, and 1 inch respectively. These are of tempered

steel, graduated on both sides in either of the two following styles: 32ds on one side and 64ths on the other, or 50ths on one side and 100ths on the other. The holder carries a split chuck in its lower end, adjusted by the knurled nut at the top of the barrel. The rules can be set in it at various angles to suit the case in hand. The barrel of the holder is knurled for a finger grip.

The Brown & Sharpe Mfg. Co. has also put up a micrometer caliper set, carrying instruments of three sizes, giving a range of from 0 to 3 inches in English measurement, or from 0 to 75 millimeters in the metric style. The 1- and 2-inch instruments are of standard type, while the 3-inch caliper has

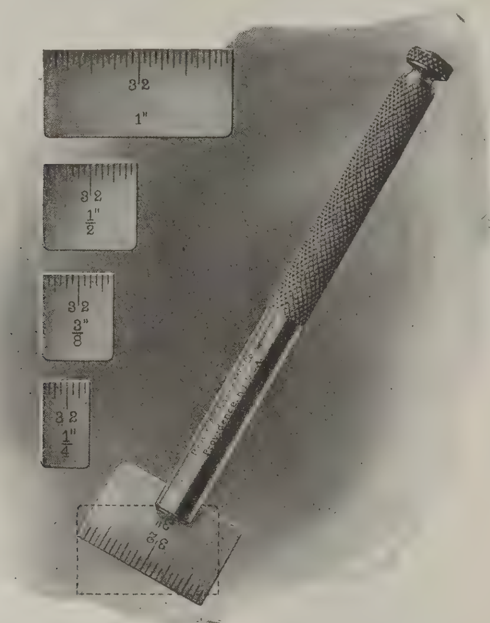


Fig. 2. Set of Short Steel Rules with Holder.

a frame of I-beam section which combines lightness and rigidity. They are furnished either with or without the ratchet stop. A standard reference disk is provided for adjusting the 2-inch caliper, and a standard end measuring rod for the 3-inch size. The whole is neatly arranged in a substantial case, lined with velvet and covered with leather.

ELECTRIC FAN FOR SINGLE PHASE CURRENT.

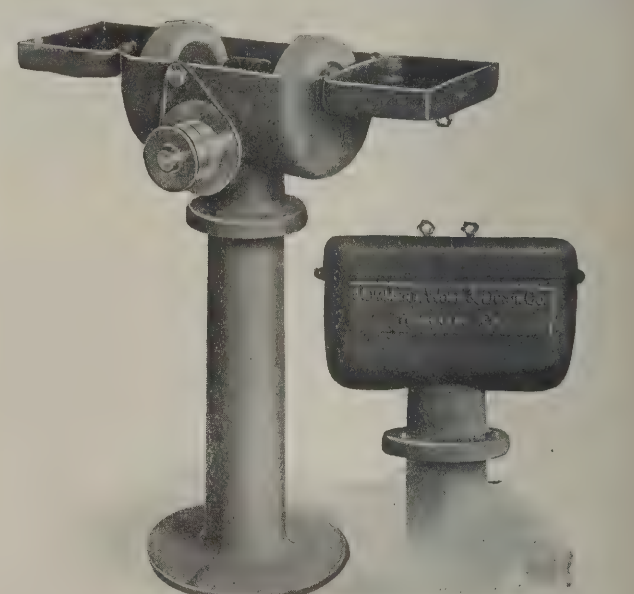
The Western Electric Co., of New York and Chicago, has devised a fan motor for use on single phase alternate circuits, which does away with most of the difficulties usually experienced when dealing with a current of this kind. The induction motor has generally been used for this service. It has one great drawback, however, and that is its uncertainty in starting immediately after the current has been turned on. The ordinary induction motor will not run properly until it gets up to the proper speed, the starting torque being so small that several spasmodic revolutions of the armature are required before it gets down to work. The new Western Electric fan motor is a commutating machine. It starts positively when the current is turned on, because it does not act on the induction principle, but in the same way as the regular series direct current fan motor. Other mechanical features of the device are: The improved bracket or standard which allows it to be used as a desk or bracket fan at will; the fact that the working parts are completely enclosed from injury by dust or dirt; and the improved design of the blades, which are built to follow specially designed lines, furnishing a maximum breeze with a minimum current consumption.

EDGE TOOL GRINDER WITH REVOLVING OIL STONES.

The accompanying halftone shows a novel machine designed for quickly sharpening edge tools of various kinds, superseding the grind stone and the oil stone as well, doing the work of both in a quicker and more satisfactory manner. The machine, as shown, is mounted on a pedestal at a convenient height, and carries a horizontal spindle with a wheel at each end, enclosed within a casing forming a part of the frame of the machine. The spindle is driven by spiral gears from a shaft having driving pulleys at the rear, out of the way of the operator, who is thus free to stand at the front or at either end of the tool, as may best suit his convenience. Of the two wheels on the main spindle, one is comparatively coarse and free cutting. This is used for the roughing cut. The second stone is finer, with the nature of an oil stone, and no final treatment on a hand stone is required.

The wheels may be run in either of two ways. A bath of oil (kerosene answers the purpose very nicely) may be used in the casing, to prevent the tool from heating, and keep the surface of the stones clean and free from glazing. In this case the wheels should revolve at the rate of about 340 revolutions per minute, which is not fast enough to throw the liquid. An alternative method is to speed the wheels up to about 700 revolutions per minute, saturating them with kerosene before starting. The wheels readily absorb the oil, and when not in motion appear to be dry, but as soon as they start to revolve, the oil is brought to the surface by centrifugal force. Here the adhesion of the oil to the stone overcomes the centrifugal force and holds the oil right on the surface of the wheels. After the stones have been once saturated, it is only necessary to occasionally put on a few drops of oil. In this way the same results are obtained as if they were run in a continuous bath. This scheme is rather to be preferred, as the work is done almost twice as fast.

The wheels are enclosed in a casing, which is provided with two lids or covers, serving to protect the wheels from accident when not in use, and also to keep out the dust with which the shop atmosphere is usually charged. When open, the lids act as oil trays to catch any oil which might run along



Revolving Oil Stone Tool Grinder.

the tool and drop off. On being closed the lids return the oil to the receptacle in the casing.

There is a small supplementary spindle driven by a round belt from the driving shaft, to which may be fastened either of two round faced grinding wheels, providing for sharpening gouges and molding bits. This machine is built by the Mummert, Wolf & Dixon Co., of Hanover, Pa.

IMPROVED NO. 2 1-2 BATH UNIVERSAL GRINDER.

The two halftones shown herewith illustrate an improved form of the grinder, built by the Bath Grinder Co. of Fitchburg, Mass. The changes which have been made have greatly increased the efficiency of the tool for all classes of work for which it was intended. This machine was described in the March, 1905, issue of MACHINERY. It will be noted that a marked improvement has been made in the spindle head over the old pattern. It is much heavier, and is fitted with taper split boxes whose large ends are at the ends of the head, thus giving rigidity to the spindle close up to the wheels. Surrounding the spindle box at the right hand of the spindle head is a projecting square flange, to which the wheel hood is

clamped. The clamp screw for binding it is in a straight line under the spindle, making the attachment useful as a safeguard in case of breakage of the wheel. The spindle head is elevated by the vertical hand-wheel on top of the machine, a graduated dial giving the movement to within 0.001 inch. The spindle is driven by a horizontal belt, and any belt tension desired can be obtained by the adjustment nuts shown on the rod at each side of the cone frame in Fig. 2.

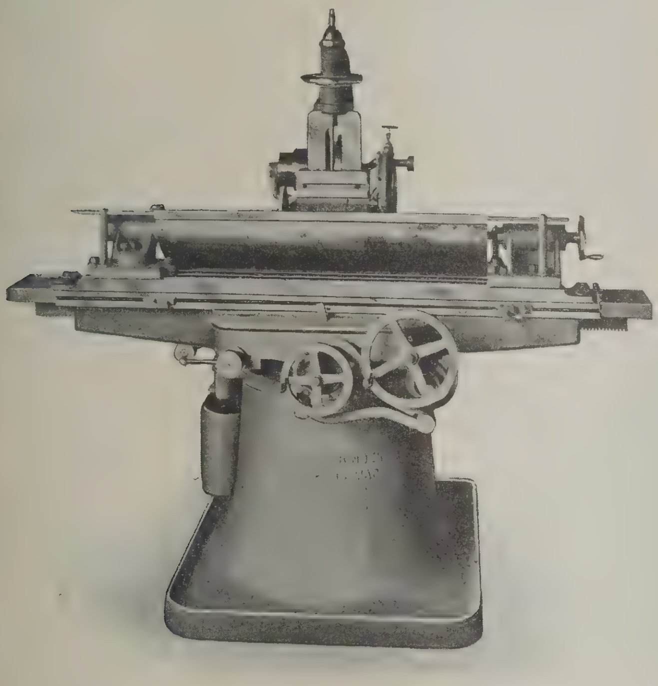


Fig. 1. Improved Bath Universal Grinder.

An improvement which adds greatly to the rigidity of the machine is the lengthening of the bearings of the table slide. The reversing of the table and its starting and stopping, are controlled by the same lever, shown at the left-hand side of the apron opposite the two hand-wheels. By this construction, in all kinds of grinding it requires only one hand of the

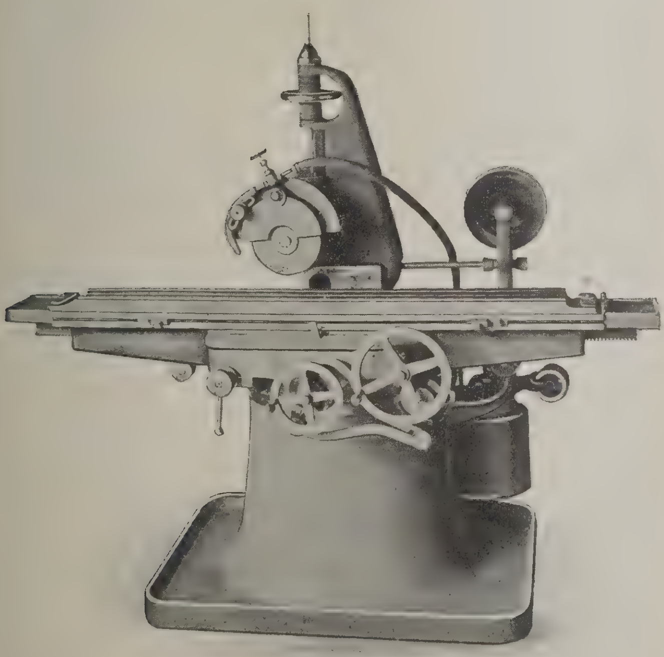


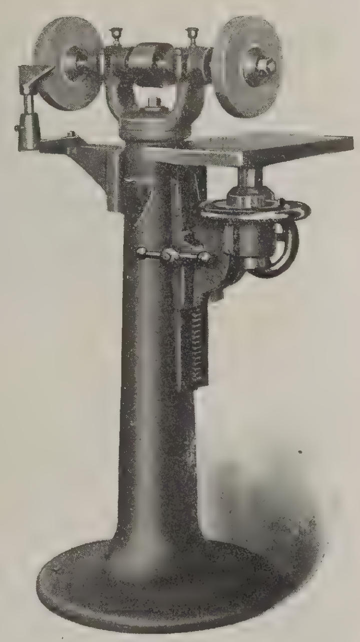
Fig. 2. The Bath Grinder arranged for Surface Grinding.

operator to reverse or stop the machine, leaving the other hand free. The table may be shifted about as shown in Fig. 2 to adapt the machine to surface grinding. An outboard support may be used if desired, in surface grinding and similar operations. It is attached to the face of the head by two bolts, being located by a tongue entering the groove shown in Fig. 1. On the projecting end of the arm is a phosphor bronze bearing, the lower end of which is adjustable to suit the spindle. This assures absolute rigidity and prevents spring in the spindle when taking heavy surface cuts. Mounted on the end of the arm is a wheel hood arranged for holding the water spout. In this case the water spout is used on either wheel hood as shown.

Suitable attachments have been provided to adapt the machine to a wide range of work, such as cylindrical and internal grinding, cutter and reamer grinding, etc. These include a rigid support for the internal grinding spindle; suitable holders, stops, etc., for small tools, vise, live spindle and chuck for head-stock; and an assortment of back rests, wheels, wrenches, etc. The capacity of the machine is as follows: from the center of the spindle to the top of the swivel plate is 11½ inches; it takes 36 inches between centers, and may be furnished to swing either 9½ or 14 inches. In surface grinding, the wheel covers an area of 36 inches by 8 inches. Complete with all attachments, the machine weighs 3,500 pounds.

MICROMETER FEED SURFACE GRINDER.

The La Salle Machine & Tool Co. of La Salle, Ill., has recently begun the manufacture of a line of machine tools. The first tool of this line is shown in the accompanying halftone. It is a surface grinder, intended for tool-room and general shop use, for fitting keys, sharpening punches and dies, and for the innumerable small jobs always coming up to be filed or ground.



Surface Grinder with Micrometer Adjustment for the Table.

Especial attention is called to the design of the work table. It has a rapid adjustment of the knee on the column by means of a rack and pinion operated by the hand-wheel at the right, and clamped by the hand nut at the left. The table is carried by a stiff post which may be adjusted vertically in the knee, and is prevented from turning horizontally by a key. A hand-wheel, as shown, encircles this post and provides a fine adjustment of the work table for depth of cut. This hand-wheel carries a dial, graduated to read in thousandths of an inch. The division marks being 3-16 inch apart, finer adjustments may readily be estimated. A dust ring is provided, which preserves the elevating screw from injury due to the accumulation of grit and emery dust.

The table is 8 x 14 inches, and has a vertical travel of 12 inches on the guides and ¾ inch by the micrometer wheel. The spindle runs in cast iron bearings at 3,000 revolutions per minute. All the bearings are adjustable for wear. A vise is furnished for clamping pieces too small or irregular to be slid on the table. The net weight of the machine is 300 pounds.

BURR COLD SAW.

John T. Burr & Sons, 34 South 6th St., Brooklyn, N. Y., have brought out a cold saw which is intended to take the place of the usual power hack saw. For this purpose it has been given some of the special features of that machine without sacrificing the good points inherent in the rotary type of blade, which is naturally a much more rapid and accurate instrument.

The blade is driven by steel spur gearing and a worm and worm gearing, a ball thrust being provided for the worm. The feed is by gravity, a weight and lever being used. This keeps the saw up to its work at all times, even though the blade may be considerably out of round. The saw used is 10

inches in diameter by 3-32 inch thick, and it will cut off blanks square within 0.005 inch in the range of the machine. The saw blades should last for months of steady cutting. They can be ground when necessary on a bench grinder furnished with the machine. A stock stop is provided so that any number of pieces may be cut off to the same length. The holding device provided allows the clamping of rounds, flats, squares and other shapes not over 3 x 3½ inches in extreme dimensions.

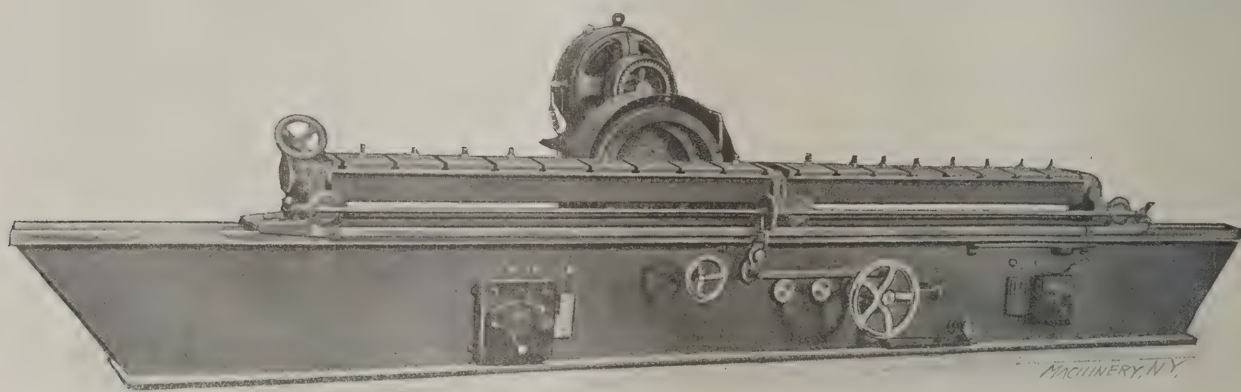
TWELVE-FOOT MOTOR-DRIVEN CUP-WHEEL KNIFE GRINDER.

The unusually heavy knife grinder shown in the illustration below, is one of the latest products of the Bridgeport Safety Emery Wheel Co., Inc., of Bridgeport, Conn. The whole machine is strongly constructed, both the bed and the emery wheel bracket being made in solid cabinet form. The cup emery wheel is 24 inches in diameter and 8 inches deep, with a 2-inch rim. With a wheel of such large diameter there is more cutting surface than usual, so that it will not wear out as fast as a smaller wheel. With the cup form, the periphery is always driven at the same surface speed, irrespective of whether the wheel is new or nearly worn out. It is usually set square with the work so as to give a flat surface to it, but when desired it may be swiveled to a slight angle to give a concave shape to the edge of the blade being ground. This swiveling is facilitated by the fact that the wheel is motor driven, thus avoiding the trouble that would otherwise arise from twisting or slacking the driving belt. The motor, which is 7½ horse-power, is geared to the wheel spindle with a cut gear and pinion, giving the wheel a speed of about 450 revolutions per minute. As the wheel wears down, it may be moved in towards the work by the small hand-wheel seen at the front of the bed.

The knife blade being ground is clamped to the heavy square column or knife bar shown on the table. This knife bar is very rigid, so that long knives can be clamped down to it firmly, taking out the wind and spring caused by tempering. In addition to the usual end supports, there is an extra central support as shown. One end of the bar carries a graduated dial, so the work can be set and ground to the same angle each time. The knife bar is adjusted for the angle by means of a worm, worm-wheel and large hand-wheel. The knife bar is fed forward to the wheel automatically by bevel gears and cross feed screws at each of the three supports as shown, the feed being automatically operated by the reversing mechanism through an adjustable dog and ratchet, which can be arranged to give as fine a feed as 1/4,000 of an inch. It will stop feeding and grinding at any point, so that when properly adjusted and set in motion no attendance is required.

The carriage is driven back and forth by a 5-horse-power motor, its mechanism being entirely disconnected from that of the spindle. This movement is strongly back geared, and is friction driven through an all-geared reversing mechanism, operated by adjustable dogs attached to the front of the carriage. By this arrangement the motor itself runs continuously in the same direction. It will be noted that the bed of the machine is very long, so there is no tendency for the bar to be sprung and its accuracy impaired by long over-hang at the end of its travel.

The weight of the machine with the length of traverse shown, 12 feet, is 9,000 pounds. It is made in lengths up to and including 15 feet.



Knife Grinder of 12-foot Capacity, built by The Bridgeport Safety Emery Wheel Company.

BURKE DOUBLE SPINDLE MILLING MACHINE.

The Burke Machinery Co., of Cleveland, Ohio, is building a novel milling machine designed for typewriter parts, and similar work. The machine is a hand miller, of interesting construction. The novel feature is the use of two spindle heads, which may be adjusted to give a distance of from 4 inches to 6½ inches between the centers of the spindles. By this means, two ends of a piece can be milled at the same time, thus saving labor and insuring accuracy and alignment. The longitudinal feed of the table is 6 inches, the cross feed 2½ inches, and the vertical motion of the knee 5½ inches. The working surface of the table is 12 x 4 inches. The machine and countershaft together weigh about 400 pounds.

NATIONAL ASSOCIATION OF MANUFACTURERS' TWELFTH ANNUAL CONVENTION.

The National Association of Manufacturers held its twelfth annual convention and banquet May 20, 21 and 22 at the Waldorf-Astoria Hotel in New York City. The credentials of over 500 members were received, and the convention was perhaps the most important of any held in the history of the association. Mr. James W. Van Cleave, of St. Louis, Mo., was re-elected president. Among the speakers at the business sessions were Hon. Charles A. Prouty, of the Interstate Commerce Commission, "Further Railroad Legislation"; Mr. Charles M. Pepper, special agent of the Department of Commerce and Labor, "Foreign Trade: How to Get It and Keep it"; Dr. Charles P. Neill, Commissioner of Labor, "Certain Aspects of the Child Labor Problem"; Mr. Arthur D. Dean, "Trade Schools: The Manufacturer of the Pedagogue Sort." Captain Henry A. Castle stated in his address, "Needed Postal Reform," that one-cent postage was possible if present wastes were prevented. A bronze plate bearing a testimonial inscription was presented to Mr. David M. Parry in recognition of his work for the association during the four years that he was its president. At the banquet in the evening of May 22, at which about 500 were entertained, the guest of honor was Hon. Oscar S. Straus, secretary of the Department of Commerce and Labor. Mr. Straus spoke with vigor for fairness in the dealings of labor and capital and for unbiased treatment of each alike. He said that immigration was largely responsible for our great prosperity and the variety of our manufacturing industries. Rear Admiral Charles D. Sigsbee, of the navy; Major-General J. Franklin Bell, of the Army, and others, spoke. The sentiment of the majority of the members of the association in regard to the present tariff is in favor of revision and reform. A resolution was adopted for the establishment of a non-partisan tariff commission similar to the present Interstate Commerce Commission. A most radical proposition was the request by President J. W. Van Cleave for a fund of $500,000 per year for three years to be used for the establishment of the "open shop," combating strikes and "labor" legislation, and meeting labor troubles in general.

INDUSTRIAL NOTES FROM EUROPE.

BRITISH TRADE ENTERPRISES.

Trade generally remains exceedingly brisk, though several matters in connection with wages in cotton trade and engineering circles cause considerable anxiety. Engineers have received a 2½ per cent advance in Manchester, but have been refused in Birmingham. An attempt was made to obtain some relaxation of the agreement entered into by the Engineering Employers' Federation and the leading engineering trades unions in 1897, but, though the wording is now less peremptory in tone, the effect is still the same—that the employers exercise the right to place any man on any machine at any wages mutually agreed on. The continued prosperity of the cotton trade, which favorably affects many other industries, is causing demands for increased wages from all classes of work people. Federations of all branches of the trade are being gradually forced on both employers and workpeople, with the result that any struggle would be of such a comprehensive character that every possible conciliatory influence will be brought to bear to prevent such a disaster. Considerable distress is being experienced at Woolwich in consequence of discharges of workmen, on a large scale, from the arsenal. This course is more or less bound to follow the fact that military requirements are now on a peace footing.

A number of improvements are being carried out at Liverpool with a view to keeping the port suitably equipped for dealing with modern shipping. The Mersey channel is being deepened 10 feet, so that it will have a depth of 37 feet at low water. The increased facilities at Southampton are no doubt partially responsible for the increased activity shown at Liverpool. Shipbuilding during the first quarter of the year was not quite so brisk as in the corresponding period of 1906, but the Clyde record was 63 ships, totaling 121,000 tons, which included a good foreign demand. The Elswick works on April 13 launched the *Invincible*, cruiser, 530 feet long, or 50 feet longer than any other cruiser, 78 feet 6 inches broad and 17,250 tons displacement. She is fitted with Parsons turbines of 40,000-horse-power, water-tube boilers, and will steam 25 knots. The vessel is to be completed and delivered in twelve months from ordering. Several similar vessels—which are the *Dreadnoughts* of the cruiser class—are being built on the Clyde. Another interesting naval vessel just launched at Sunderland by Sir James Laing & Son, Ltd., is the *Cyclops*, which is intended to accompany a fleet as a comprehensive naval repairing shop. She is 460 feet long by 55 feet broad and 45 feet deep. The lower deck is fitted up as a foundry, the other decks providing all facilities for boiler making, engine fitting and machining, coppersmiths, carpenter and electrical work, etc. An ice-making plant will be installed, together with a water-distilling plant, sufficient for the fleet. A wireless telegraphy outfit is included, and the picked crew will be about 300 strong.

Considerable additions and improvements to plants generally have been taking place in British iron and steel and shipbuilding centers during the last few years. In the smelting industries advantage has been taken of American ideas, modified to suit local conditions, and the benefit experienced is already well marked. In shipbuilding the developments are mostly on British lines, though some heavy lifting tackles have been adopted from German sources. Armstrong, Whitworth & Co., Elswick and Manchester, and Beardmores, Glasgow, have been very prominent in the way of extensions in shipbuilding and armor plate plants. Touching on shipbuilding, most interesting papers have recently been presented before, and discussed by, the Institution primarily interested in the topic. The paper by Mr. Luke, detailing the plating methods employed while building the *Lusitania*, draws attention to the remarkable advances in the rolling of steel plates, since iron and steel vessels were first built. In the case of the *Lusitania*, the shortest plates were 32 feet long, and the width only limited by the gaps of the hydraulic riveters used. The *Engineer* suggests that the building of future vessels may call for plates 100 feet long and 10 to 12 feet wide *produced in the shipyard itself*. The riveting on the above ship was equal to the best boiler practice, punching hardly being resorted to. All drilling was done in place, and the plates removed, the drillings cleared away, and all holes countersunk to remove burrs. As showing the multiplicity of auxiliary equipment on board modern liners, it may be mentioned that the Chadburn Ship Telegraph Works, Liverpool, received a contract for 500 ship's telegraphs for installation on the two new Cunarders.

Overhead tracks with switches, turntables, etc., for use in workshops, etc., have received a good measure of appreciation during the last few years, this system proving very elastic and adaptable in cases where traveling cranes are inadmissible. Nettlefolds, Ltd., are exploiting the Coburn trolley track, while Herbert, Morris & Bastert, Ltd., Loughborough, and Vaughans, Ltd., Manchester, are other typical exponents of the idea. The hand lifting blocks in connection with the tracks have come in for much attention, and several very meritorious spur-geared blocks are coming into use which show a distinctly improved mechanical efficiency over many other forms of lifting tackle. In fact, the inexperienced buyer is likely to be bewildered by the multiplicity of good things offered him, and there is little doubt that the treatment of the whole subject has recently been raised to a higher level. Not long ago, Great Britain was an almost negligible quantity as regards the building of automobiles—as now understood—but the last year or two has witnessed a decided change in this respect, as may be seen from the fact that for the first three months of this year the value of the exports in this line was not less than $552,970. There are signs that the needs of would-be purchasers, whose means are only moderate, are to receive some approach to adequate attention.

Several tool builders appear disposed to question the superiority of the vertical boring and turning mill over a well designed lathe, for dealing with such jobs as gas engine flywheels. Broadbent, of Sowerly Bridge, has built, at moderate cost, some very successful lathes for this purpose. Shanks & Co., Johnstone, build a quadruple-geared slide break lathe for somewhat similar work. This lathe has a self-contained gap frame to swing work of large diameter and great width. The head-stocks are 30 inches high and the bed 4 feet wide, and jobs 14 feet diameter and 7 feet 6 inches wide may be swung in the gap. It may be remembered that an interesting tool for work of this class by J. Butler & Co., Halifax, was described in the issue for April. Grinding machines—of precision—were, years ago, considered almost sacrosanct as regards their manufacture, but quite a few makers on this side are tackling the subject with very encouraging results, and the experience thus gained is distinctly to the good of the British machine-tool trade. Off-hand in this line we may mention J. J. Guest, Birmingham; G. Birch, Salford; The Churchill Machine Tool Co., Ltd., Manchester; The Newall Engineering Co., Ltd., Warrington, etc., and disk grinders embodying all degrees of efficiency find no lack of sponsors. Pneumatic tools find constantly increasing application. For blacksmith work the power hammers built by B. & S. Massey, Manchester, are very successfully handling much of the work formerly dealt with by steam hammers. They are driven by belt or electric motor, two cylinders being used, in one of which the air is compressed, and in the other the tup-holding rod and piston work in the same manner as the steam hammer. These hammers are made in sizes from 112 pounds to over 2,000 pounds, the sizes being designated by the weight of the tup used. This class of hammer lends itself admirably to the simplification of workshop lay-out, the problem of condensation from long lengths of steam pipe, and annoyance, due to water dripping from the piston rod stuffing-box onto the work, being eliminated. Their general appearance and method of working is much the same as that of the steam hammer, and workmen have no trouble in adapting themselves to their use. The manufacture of pneumatic chipping and riveting hammers, drills, etc., is growing in this country, the latest concern to enter this field of production being Smith & Coventry, Ltd., Manchester, who are making excellent records with their "Stox" hammers, which use two pressures of air—100 pounds for the blow, and 15 pounds for the return stroke. A special merit of this system is the absence of vibration, a feature feelingly appreciated by operatives handling them.

Manchester, Eng., April 27, 1907. JAMES VOSE.

THE MACHINE TOOL BUILDERS' CONVENTION.

The convention of the National Machine Tool Builders' Association was opened at Old Point Comfort, Virginia, May 14, 1907. The address delivered by President Woodward dwelt on the growth of the association and its increasing influence. Appropriate reference was also made to the four prominent members who have died since the last general meeting. These are H. J. Hendey, of the Hendey Machine Co.; Edward P. Bullard, of the Bullard Machine Tool Co.; Joseph Flather, of Flather & Co. Inc.; and Harry C. Hoefinghoff, of the Bickford Drill & Tool Co.

A report was received from the Committee on Uniform Cost Accounting. This was carefully prepared, going very minutely into the fundamental principles of cost accounting. It was accompanied by an elaborate chart showing the elements entering into the cost of production on machine tools. Discussions of this report were contributed by President Woodward, C. H. Norton, and E. Payson Bullard. President Woodward spoke of the value of an accurate knowledge of costs in preventing unintelligent competition in a falling market. Mr. Norton spoke of the necessity for checking the cost department figures by the manufacturing department, as absurd errors are often made, which it is impossible for the clerical force to recognize and rectify. Mr. Bullard explained a system in vogue in the Bullard Machine Tool Co.'s plant which did away in a large measure with the difficulty just mentioned.

Other matters engaging the attention of the members at succeeding meetings were the responsibility of foundrymen, the claims of buyers, standardization of catalogues, and the advisability of exhibiting at expositions. It was the general impression of the machine tool builders that the 6 x 9-inch size of catalogue is the most suitable for general use. In the matter of expositions, it also seemed to be fairly well agreed upon that there is little profit in doing anything with those held in this country, where the thing has been rather over done. Exhibiting at foreign expositions, however, has apparently been profitable to American manufacturers.

E. Payson Bullard, of the Bullard Machine Tool Co., Bridgeport, Conn., submitted his report on the apprenticeship question. This was well received. It advised, among other things, the adoption of a uniform system of agreement between employers and the parents or guardians of the apprentices, and the retention of a certain amount of the apprentice's wages by the employer as a surety of good conduct. It also suggested the adoption of a diploma signed by the officers of the National Machine Tool Builders' Association.

The Henry & Wright Mfg. Co., of Hartford, Conn., and the Kern Machine Tool Co., of Cincinnati, Ohio, were made members of the association.

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SPRING MEETING OF A. S. M. E.

The spring meeting of the American Society of Mechanical Engineers was held in Indianapolis, Ind., May 20-31, the headquarters being the Claypool Hotel. Following is the program of papers presented:

Report of the Committee on Standard Proportions for Machine Screws.

Preliminary Report of the Committee on Refrigerating Machines.

Collapsing Pressures of Lap-Welded Steel Tubes. R. T. Stewart.

The Balancing of Pumping Engines. A. F. Nagle.

The Economy of the Long Kiln. E. C. Soper.

Ball Bearings. Henry Hess.

Air Cooling of Automobile Engines. John Wilkinson.

Materials for Automobiles. Elwood Haynes.

Special Auto Steel. T. J. Fay.

Railway Motor Car. B. D. Gray.

The Specific Heat of Superheated Steam. A. R. Dodge.

The Flow of Superheated Steam in Pipes. E. H. Foster.

Furnace and Superheat Relations. R. P. Bolton.

The Determination of Entropy Lines for Superheated Steam. A. M. Greene.

The Heating of Storehouses. H. O. Lacount.

Performance of Cole Superheaters. W. F. M. Goss.

Experiences with Superheated Steam. G. H. Barrus.

Superheated Steam in an Injector. S. L. Kneass.

Use of Superheated Steam on Locomotives in America. H. H. Vaughan.

Analysis of Locomotive Tests. S. A. Reeve.

Materials for the Control of Superheated Steam. M. W. Kellogg.

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WHITE STAR STEAMER ADRIATIC.

The newest and biggest liner, the *Adriatic* of the White Star Line, reached her pier at New York, Thursday, May 16, 1907. She is 725 feet 9 inches long over all, 75 feet 6 inches beam, with a hull about 50 feet deep. Her gross tonnage is 25,000 tons. There are accommodations for 3,000 first-class, second-class and steerage passengers. The boat has twelve water-tight compartments and nine steel decks. The double bottom extends through the whole length of the hull. The first- and second-class compartments are finely equipped, and a number of novelties have been introduced. Among them are a dark room for the amateur photographer and a Turkish bath attached to the gymnasium. The *Adriatic* is provided with submarine signalling apparatus of the submerged bell and telephone type, by means of which the officers of the vessel can be made aware in foggy weather of their proximity to similarly fitted ships and shore stations.

* * *

OBITUARY.

William J. Johnston, founder of the *Electrical World*, and one time publisher of the *Engineering and Mining Journal*, died April 28 at his home in New York. At the time of his death he was publisher of the *American Exporter*. Mr. Johnston was born in Ireland in 1853, and his first occupation was that of a telegraph operator. He published the first periodical in the United States devoted to things electrical.

WILLIAM H. DERBYSHIRE.

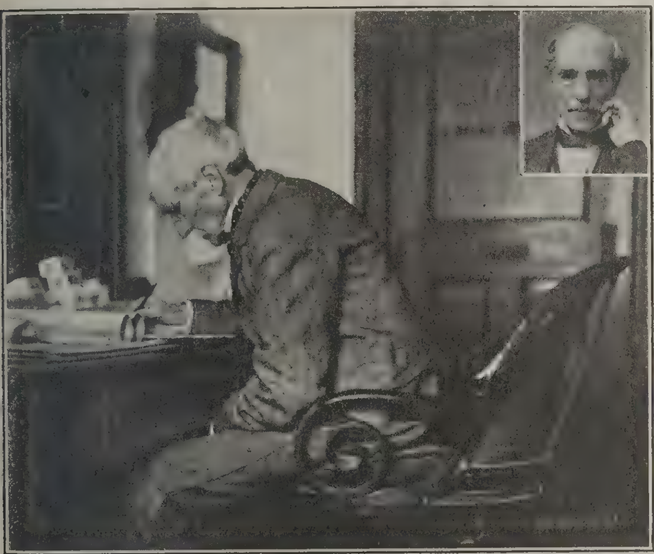
William H. Derbyshire, president of the Chambersburg Engineering Co., Chambersburg, Pa., died April 13. He was born in Canton, Ill., March, 1859. After graduating from the Polytechnic College of Pennsylvania in June, 1877, he went with the John Roach & Son Shipbuilding and Engine Works at Chester, Pa., where he remained until August, 1879, going from the Roach works to the machine tool works of Mr. Frederick B. Miles in Philadelphia. When the machine tool works and Wm. B. Bement & Sons were consolidated as the firm of Bement, Miles & Co., in 1885, Mr. Derbyshire became superintendent of the new concern, remaining in this position until November, 1897, when he formed the Chambersburg Engineering Co.

Mr. Derbyshire was a man of exceptional executive ability and engineering talent. He was an authority on smith shop and boiler shop equipment, and after the organization of the Chambersburg Engineering Co. he gave his entire time and attention to this class of machinery. He had taken out many patents on hydraulic equipment. One of them best known to the trade is his system of quick-acting hydraulic riveters and presses. The steam hammer was also the subject of numerous improvements at his hands, and steam drop hammers as well. Under his management the Chambersburg Engineering Co. has grown from a very small plant to its present extensive dimensions, the works now including a large machine shop, iron foundry, an open-hearth steel casting foundry, the total number of men at the present time employed being over 400. Although Mr. Derbyshire's death is a severe loss to the company, the organization is such that the work that he planned will be carried henceforward without interruption.

CHARLES HAYNES HASWELL.

Charles Haynes Haswell died at his home in New York May 12, 1907, of shock resulting from injuries received in a fall upon his dining-room floor, which dislocated his shoulder. Mr. Haswell, at the time of his death, was doubtless the oldest engineer in the world and was widely known as the "dean of engineers." He was born May 22, 1809, in New York, and, therefore, had nearly reached the great age of 98 years. Not-

withstanding his years, he was in good health, and was engaged in important engineering work for New York City on Riker's Island. Mr. Haswell received a classical education in the schools of New York and entered the engineering profession at the age of 19. In 1829 he was employed by the boiler works of James P. Allaire, a famous ironmaster of that period, and in 1836 became a naval engineer in the employ of the United States government. He rose to the rank of chief engineer, and in 1845 was made engineer-in-chief, which position he held until 1851. During this period he designed all of the machinery for ten ships and introduced numerous mechanical improvements. He is said to have been the first to use zinc in marine boilers to prevent corrosion. He is also



Charles Haynes Haswell.

credited with being the designer and builder of the first steam launch, called the *Sweetheart*. On retiring from the navy Mr. Haswell engaged in engineering practice in New York and for forty-two years was surveyor of steam vessels for marine underwriters of New York, Boston and Philadelphia. He retired from this post in 1893 and was since engaged in consulting work, of which municipal work for New York claimed a large share of his time. Although a civil engineer by profession he was known to most of our readers best as the author of Haswell's Mechanics' and Engineers' Pocketbook, first published in 1843 in a small volume of 284 pages, and which has just gone into its 72d edition. Harper & Bros., the publishers, state that the total number of copies printed and sold is over 146,000. This work, originally compiled when the profession of the mechanical engineer as such was almost unknown, contained much matter that is now considered outside its province, but, notwithstanding, it was and is a most valuable compendium of engineering knowledge and is highly regarded by thousands who refer to its convenient mathematical tables and other useful data. The accompanying cut shows Mr. Haswell working at his desk at his regular occupation, the photograph having been taken only a few months ago. The full-face portrait in the corner of the cut was taken several years before his death.

* * *

PERSONAL.

Miss C. M. Hawkins, graduate of the Pratt Institute Library School has been appointed librarian of the Stevens Institute of Technology. An important feature of this library is the section devoted to patent literature containing files of the Patent Office Gazette and patent specifications. This section of the library has been liberally supported by Prof. W. H. Bristol.

W. H. Booth, London, England, a well-known consulting engineer and writer on technical subjects, is on a business trip to America in the interests of the American patents on the Collier sectional rubber tire, the Renard road train, and the Reavell air compressor. If satisfactory business connections are made, Mr. Booth may make the United States his place of residence indefinitely. He is in position to dispose of foreign patents for American inventors, especially in Great Britain and France, and to assist in the advantageous location of manufacturing rights in Great Britain.

Dr. William H. Tolman, director of the American Museum of Safety Devices, who has been appointed Commissioner General of the International Paper and Publicity Exposition to be held this year in Paris, will sail early in June. While abroad, he will visit the great European museums of safety devices and industrial hygiene, to gain information concerning their accessions during the last year, and to acquire material for the American Museum of Safety Devices, to be opened in New York in the new 39th Street Building early in the autumn. Dr. Tolman will represent the Museum at the International Congress of Associations for Preventing Accidents, to be held this year in Rome, and also at the International Housing Congress to be held in London during August.

* * *

FRESH FROM THE PRESS.

Tests of Reinforced Concrete Beams. By Ernest A. Moritz. 75 pages, 6 x 9 inches. Illustrated with numerous cuts and diagrams. Published by the University of Wisconsin, Madison, Wis. Price, 30 cents.

Iron Age Directory. 331 pages, 4½ x 6½ inches. Published by the David Williams Co., New York. Price 25 cents.

This issue of the very convenient *Iron Age* Directory is of the eleventh annual edition. It is a classified index of all the concerns whose advertisements have appeared in the *Iron Age* during the preceding year..

Table of Volumes Through Air-Ways. By C. H. Kuderer. Published by C. E. Meyer, Allegheny, Pa. Price, 25 cents.

This table is printed on cardboard, and gives the cubic feet per minute for air-ways 1 x 1 foot up to 10 x 10 feet, length 1,000 feet, with pressures from 1-10 to 5 inches, water gage. The tables are calculated by Atkinson's formula:

$$Q=\sqrt{\frac{P\times A}{K\times S}}\times A\,;\ K=0\ 0000000217.$$

Tests of Concrete and Reinforced Concrete Columns, Series of 1906. By Arthur N. Talbot. 64 pages, 6 x 9 inches. Published by the University of Illinois, Urbana, Ill.

This is Bulletin No. 10, issued by the University of Illinois' Engineering Experiment Station, and is of interest and value to all engaged in reinforced concrete work. Comparatively few tests have been made on concrete columns and most of these were made on small test specimens. Tests described in this bulletin were made on the 600,000-pound testing machine belonging to the University.

Cambria Steel: Handbook of Useful Information for Engineers. Compiled by George E. Thackray. 468 pages, 4¼ x 6¾ inches. Published by the Cambria Steel Co., Philadelphia.

This book is of the eighth edition. It contains the usual matter found in handbooks of this class, being confined in general to information on structural shapes, giving weights, dimensions, properties of sections, and other matter required by the engineer when specifying steel for structural work. The typographical appearance of the book is good; it is well printed and well bound, and will be highly appreciated by those interested. In addition to the general matter, there are tables of areas and circumferences of circles, trigonometrical tables and miscellaneous information.

Tests of Reinforced Concrete T-Beams, Series of 1906. By Arthur N. Talbot. 35 pages, 6 x 9 inches. Published by the University of Illinois, Urbana, Ill.

This is Bulletin No 2, issued by the University of Illinois' Engineering Experiment Station. It describes a preliminary series of tests on reinforced concrete T-beams undertaken to determine the effect of different widths of beam which may be considered to contribute to the strength and stiffness of a beam. The tests also were made to determine the effectiveness of the metallic web reinforcement. The beams were reinforced with longitudinal rods, having a cross-section area equivalent to 1 per cent of the rectangle enclosing the beam. All the beams failed through tension in the longitudinal reinforcement.

Open-Hearth Steel Castings. By W. M. Carr. 118 pages, 5 x 7½ inches. 19 cuts. Published by the Penton Publishing Co., Cleveland, Ohio. Price, $1.50.

This book is an exposition of the methods involved in the manufacture of open-hearth steel castings by the basic and acid processes, and is compiled from a series of articles by the author published in the *Iron Trade Review* and the *Foundry*. It treats of the open-hearth furnace construction, fuels and accessories, manipulation of heats in acid process and basic practice, order of charging, chemical analyses and physical tests, blow-holes in steel castings, heat treatment and annealing, repair of steel castings with thermit, cost of equipment for open-hearth steel foundries, etc. The growth of the use of steel castings and the superiority of the open-hearth process for low-grade ores make this book of much interest to all concerned with foundry practice and general machine construction.

Technical Year Book, 1907 399 pages, 4 x 6 inches. Illustrated. Edited by Arthur C. Kelly and Charles Weekes. Published by Percival Marshall & Co., London. Price, cloth, $1.25; leather, $1.65.

This book is composed of a collection of the principal technical articles of permanent value that have appeared in the 250-odd engineering journals published throughout the world. It has chapters entitled automobiles, boilers and steam generation, cables and power transmission, electricity supply, general electrical, general mechanical, generators and motors, hydraulics, lighting, marine, mining, power, prime movers, traction and general. The guiding principle of selection is that the matter chosen shall have in a marked degree a permanent and general value as well as present interest, and it appears that the authors have made a good selection. The limit of space available has necessarily crowded out much matter that could have been used appropriately. It is hoped that the scheme will prove of sufficient popularity to admit of a substantial increase of size for succeeding years.

American Pattern Shop Practice. By H. J. McCaslin. 308 pages, 6 x 9 inches. Illustrated. Published by the Frontier Co., Cleveland, Ohio. Price $3.00.

This work is divided into six sections, as follows: Engineer Pat-

terns, Molding and Cores, Sweep Work, Gearing, Representative Patterns, and Hints, Suggestions and Rigs. Each section is separately paged, and the cuts separately numbered, the idea being to add to each section in future editions without disturbing the numbering of the pages and cuts throughout, as necessarily follows when the cuts and pages are consecutively numbered. The author is fairly well known to the readers of trade papers, having contributed valuable articles on pattern work to the press. Several of these articles substantially appear in the work, being modified to suit the conditions of the work. The line illustrations are all wax engravings and the general typographical appearance of the book is good. We believe that the book is one that will be appreciated by pattern-makers generally, inasmuch as the number of available books on pattern-making is very limited, and as this is a strictly practical work written by one who is master of his craft.

THE SEVEN FOLLIES OF SCIENCE. By John Phin. 178 pages, 5¼ x 7½ inches. 34 illustrations. Published by D. Van Nostrand Co., New York. Price $1.25.

This interesting book is one that should have a place in every public library. The main part of the book is taken up with discussions of the "seven follies of science," namely: squaring the circle; the duplication of the cube; tri-section of an angle; perpetual motion; the transmutation of metals; fixation of mercury; and the elixir of life. The problem of squaring the circle, that is, finding an exact mathematical equivalent for the area of any circle in the shape of a square, is one that has absorbed the energies of many would-be mathematicians, but it has been conclusively demonstrated that the circumference of a circle is incommensurable with its diameter. Hence the impossibility of establishing exact mathematical equivalent in a square for the area of a circle, although we are able to express the ratio of the circumference to the diameter to almost any required degree of accuracy save actual exactness. One English mathematician figured the value of π to 707 places. This problem and others of the same kind are still discussed more or less, but scientists no longer concern themselves with these ancient puzzles, as they now have something of much greater worth to investigate. The chapter on perpetual motion is probably the most interesting of all to mechanics. It illustrates a number of the weird and foolish schemes that have been devised for cheating nature and producing power without giving an equivalent. The book also contains brief discussions of minor follies known as perpetual lamps, universal solvent, palingenesy, the powder of sympathy, and interesting illusions of the senses; also a discussion of the fourth dimension, etc.

NEW TRADE LITERATURE.

THE GENERAL PNEUMATIC TOOL Co., Montour Falls, N. Y. Bulletin No. 58, on electric traveling cranes, describing features of construction.

NORTON Co., Worcester, Mass. Pamphlet entitled Testing for Safety, describing this company's system of testing Norton grinding wheels.

B. F. STURTEVANT Co., Boston, Mass. Bulletin 146 of electric propeller fans, illustrating and describing various forms of this type of fan for moving air.

FLANNERY BOLT Co., Pittsburg, Pa. Leaflet of Tate flexible staybolt for locomotive boilers, giving requirements that should be complied with in the construction and application of flexible stay-bolts.

IDEAL OPENING DIE Co., 24 West St., New York. Catalogue descriptive of the "Ideal" opening die, which utilizes the torsion due to threading to open the dies when the limit of thread has been reached.

REVOLUTE MACHINE Co., 523 West 45th St., New York City. Catalogue of the Everett-McAdam blue-print machine describing its parts, principle and efficiency.

THE S. OBERMAYER Co., Cincinnati, O., has issued a set of circulars setting forth the advantages claimed for Ceylon plumbago and other products manufactured by this company.

PH. BONVILLAIN & E. RONCERAY, Paris. Catalogue describing the "Universal" system of machine molding developed by this concern. This company exhibited examples of its product at the Convention of the American Foundrymen's Association held in Philadelphia in May.

T. R. ALMOND MFG. Co., 83 Washington Street, Brooklyn, N. Y. Catalogue of Almond drill chucks, Almond right angle transmission, Almond turret heads, Almond flexible arms for electric lights, and Almond flexible steel tubing.

FERRACUTE MACHINE Co., Bridgeton, N. J. Catalogue No. 15, being a temporary issue of their regular catalogue referring to nearly 500 kinds and sizes of foot and power presses for working bar and sheet metals, paper, cloth, leather, etc.

TABELL ANGAENDE SKÖTSEL AF DYNAMOMASKINER, being a translation by Sigurd Christenson of MACHINERY'S data sheet supplement "Diseases of Dynamos and Motors," September, 1906. This has been printed in pamphlet form for use in the Coast Artillery Schools of Sweden.

WESTERN ELECTRIC Co., Chicago, Ill. Pamphlet entitled "Some Interesting Western Electric Co. Facts," mentioning houses and agencies, principal manufactures, system throughout the plant, etc. Also a pamphlet containing instructions for installation and maintenance of telephone machines.

THE BILLINGS & SPENCER Co., Hartford, Conn., has divided its present issue (1907) of circulars into two books, one being a general catalogue of machinists' tools, etc., the other being devoted to fine tools and specialties. Both are illustrated and contain descriptions and price lists of these tools.

GISHOLT MACHINE Co., 1316 Washington Ave., Madison, Wis. New catalogue illustrating and describing Gisholt lathes (American type). The American semi-automatic turret lathe described is especially adapted for finishing such classes of work as gear blanks, cylinder heads, fly wheels, pulleys, etc., up to full swing of machine.

WM. GARDAM & SON, INC., 45-51 Rose Street, N. Y. Bulletins No. 2 and 14 of sensitive drill presses. These include very light bench sensitive drills and column sensitive drills having a capacity up to ½-inch hole.

CINCINNATI MACHINE TOOL Co., Western Avenue and Frank Street, Cincinnati, Ohio. Catalogue of the Cincinnati upright drilling and tapping machines. Special attention is called to the patent gear tapping attachment with which about half the annual product of the company is now equipped. The company has a new three-story plant, which is illustrated in catalogue.

JOSEPH DIXON CRUCIBLE Co., Jersey City, N. J. Booklet, A Study in Graphite, by Prof. W. F. M. Goss, giving in detail a series of tests made by him at Purdue University. The book opens with a dissertation by Prof. Goss based on the conclusions drawn from the results of the tests. Then follow complete descriptions of the tests together with illustrations of the testing machine.

BROWN & SHARPE MFG. Co., Providence, R. I. Eight-page catalogue describing new machinist's tools. These tools are a removable point pocket scriber; spacing attachment for automatic center punches; pocket automatic center punch; combination caliper and divider; micrometer caliper set, range 0 to 3 inches; short steel rules (5) with holder for measuring in constricted places such as keyways, etc.

FORBES COMPANY, Philadelphia, Pa. Catalogue descriptive of the Forbes system of sterilization for drinking water of plants, mills and factories, and all concerns employing labor. The matter of supplying safe drinking water to the employes of manufacturing plants is of great importance, not only from the humanitarian view-point, but for business reasons as well. The Forbes system is used by the Link-Belt Company, Philadelphia.

THE English edition of *La Revue de l'Ingenieur et Index Technique* will in future be published by Mr. M. J. Fitz-Patrick, 51 rue de l'Aurore, Brussels, under the title of *The Technical Index*. This publication is a systematic record of current literature of the world. It lists the important articles of the technical press, proceedings of technical societies and new books on technical subjects. The subjects are classified by the Dewey decimal system. The subscription price of the ordinary edition is $2.50 yearly, and of the card index edition, $4.00.

WESTERN ELECTRIC Co., Chicago, Ill., is about to issue the 1907 edition of its supply catalogue. This will be a volume of 700 pages, and will list everything of importance in the electrical line. The supply catalogue gotten out by the company in the past few years has been greatly in demand by dealers and others all over the country, because it contains not only a complete list of the material handled by the company, but features of general interest to the electrical trade. The present edition will be much more complete and instructive than any heretofore published by the company.

MANUFACTURERS' NOTES.

WELLS BROS. Co., Greenfield, Mass., has moved its New York store from 56 Reade St. to 126 Chambers St.

THE New York offices of the *Iron Trade Review* have been changed from 150 Nassau Street to the new West Street building, 90 West Street.

THE CASE MFG. Co., Columbus, O., manufacturer of cranes, has just completed a large addition to its factory which will increase the output about 30 per cent.

SPRAGUE ELECTRIC Co., New York, is manufacturing and marketing the dynamo-dynamometers for testing automobile engi es, developed by Mr. Joseph Tracy.

F. H. BROWN MACHINERY Co. has opened an office at 1102 Park Building, Pittsburg, Pa., where a number of machine tool manufacturers will be represented. The company will also buy and sell second-hand machinery.

NORTON GRINDING Co., Worcester, Mass., manufacturer of cylindrical grinding machinery, bench and floor grinding machinery, universal tool and cutter grinders, is erecting a building which will double the present capacity of the company.

NORTHERN ENGINEERING WORKS, 26 Chene St., Detroit, Mich., has furnished the plant of the Edison Sault Electric Co., Sault Ste. Marie, Mich., with a second 15-ton alternating current electric traveling Northern crane.

EBERHARDT BROS. MACHINE Co., 66 Union St., Newark, N. J., gear specialist, is building a one-story addition to its factory. The extension will accommodate several new planers, and a new engine room, and will increase the production of automatic gear cutting machines.

FULTON MACHINE & VISE Co., Lowville, N. Y., advises us that its shop, machinery and patterns were destroyed by fire on Sunday, May 19. The company desires to obtain catalogues of all kinds pertaining to its business from various manufacturers, as its files were completely destroyed.

WILMARTH & MORMAN Co., 580 Canal St., Grand Rapids, Mich., will have an exhibit in space 984 at the American Railway Master Mechanics' Association Convention to be held at Atlantic City, N. J., June 12 to 19. The secretary of the company, Mr. Charles E. Meech, will be in charge.

GENERAL ELECTRIC Co., Schenectady, N. Y., has now permanently located its San Francisco offices in the Union Trust building, in San Francisco. Since the fire the office had been located in the Union Savings Bank building, at Oakland, large temporary warehouses having been erected in the same city.

J. H. WAGENHORST & Co., Youngstown, Ohio, recently sold Wagenhorst electric blueprinting machines to the Babcock & Wilcox Co., Barbertown, Ohio; American Steel & Wire Co., Joliet, Ill.. Monongehela River Consolidated Coal & Coke Co., Pittsburg, Pa.; Thompson Stationary Co., Vancouver, B. C., and others.

THE ROBBINS & MYERS Co., Springfield, Ohio, recently moved its New York office and salesroom from 66 Cortlandt St. to 145 Chambers St., where the company occupies a 5-story building. The new location provides good facilities for carrying a larger stock and making prompter deliveries than before. The increase in their Eastern business in the power motor and fan motor line made the change necessary.

L. H. GILMER & Co., Philadelphia, Pa., have incorporated their business under the name of L. H. Gilmer Co., with a capital stock of $100,000. Mr. Ludwell H. Gilmer is the president of the concern, and Mr. G. W. Gilmer, Jr., vice-president. The company will have increased facilities for manufacturing the Gilmer belting and endless belts, and will also carry on a jobbing business in machinery and supplies.

HILL, CLARKE & Co., INC., have removed their New York store to the West Street Building, 136 Cedar Street, occupying the northwest corner of the ground floor. Their new quarters are much larger than the old, and unusually well adapted to their business on account of the excellent light, arrangement and other features. The location is convenient to the machinery trade, and many concerns in their line have offices in the West Street Building.

THE F. W. SPACKE MACHINE Co., Indianapolis, Ind., has completed a two-story addition to its factory, each floor containing about 10,000 square feet of floor space. The company recently purchased the entire machinery equipment of a local machine shop retiring from business, and this will be installed along with the new equipment. The additional machinery and space will about double the capacity of the company.

THE MICHIGAN CRUCIBLE STEEL CASTINGS Co., 248-250 Guoin St., Detroit, Mich., has been incorporated under the laws of the state of Michigan for the purpose of manufacturing crucible steel castings, special attention being paid to automobile work. The firm expects to be ready to produce castings on or before the first of May. The president and general manager of the company is R. F. Flinterman and the superintendent of the plant is Mr. MacLeod.

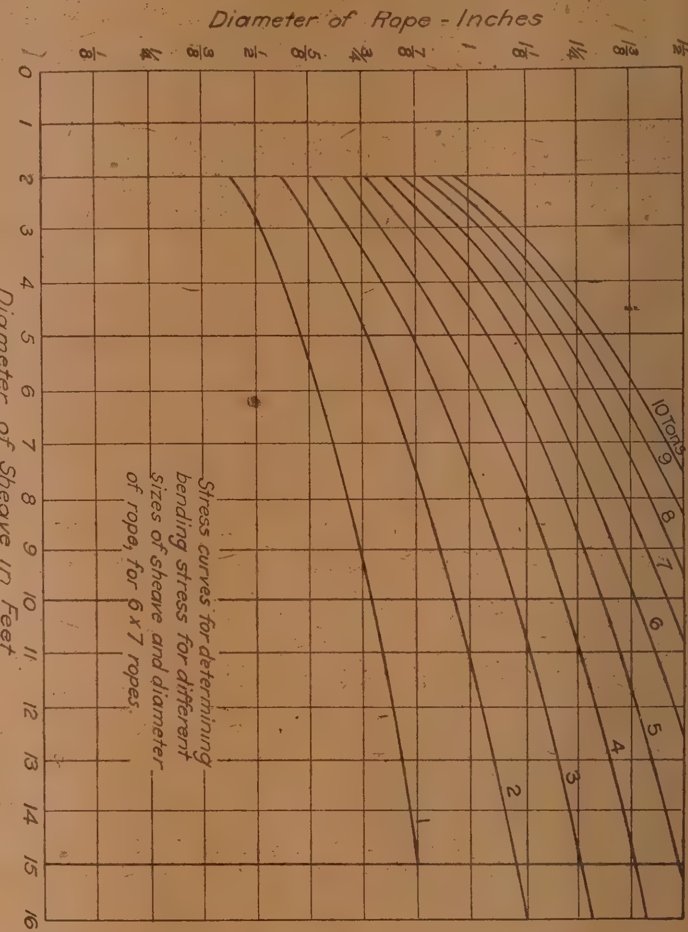
NORTON Co., Worcester, Mass., manufacturer of grinding wheels made of Alundum and other abrasive specialties, is to erect a large addition to its Worcester works. The building designated as Plant will be extended to about 200 feet in length by 111 feet in width, which will more than double the present capacity. The building will also be fully equipped with kilns, mixing machines, shaving machines, etc., so as to permit of a large increase in output.

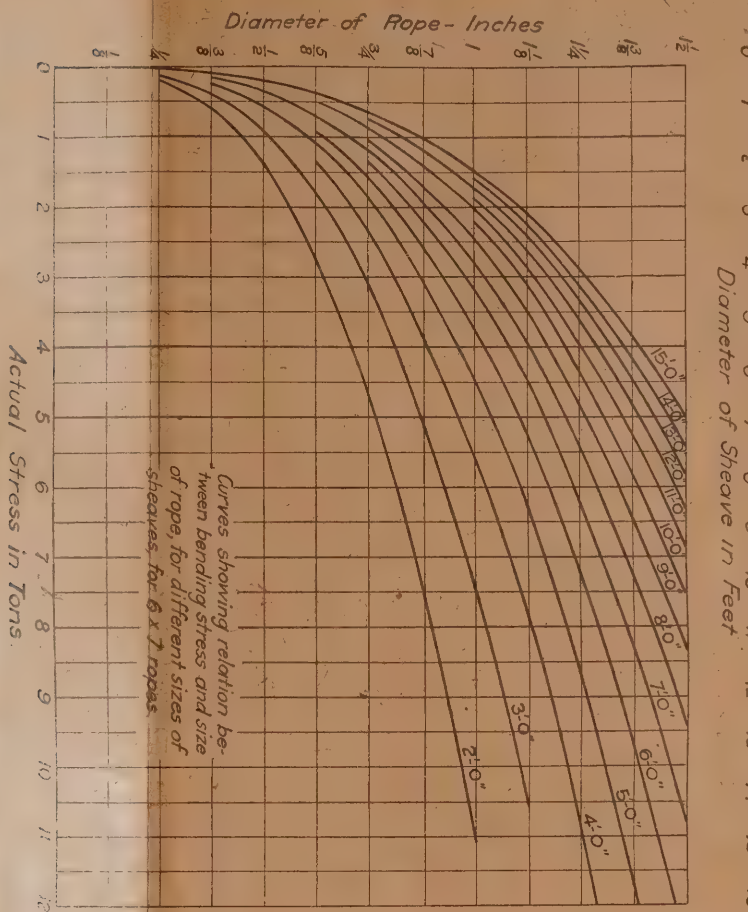
EBERHARDT BROS. MACHINE Co., 66 Union St., Newark, N. J., announces that, because of the continued increase in the number of orders for its automatic gear-cutting machines and crank shapers, the company will discontinue the manufacture of crank shapers, and will give exclusive attention to its specialty, the design and manufacture of automatic gear-cutting machines and gearing. The Machine Sales Co., of New York City, has arranged to take over the production of the shapers, and will manufacture them at its plant at Peabody, Mass. There will, therefore, be no interruption in the supply to the market.

Contributions and data suitable for publication in these Data Sheets are so

BENDING STRESSES IN WIRE ROPES.—I.

Contributed by James F. Howe.





No. 44, Data Sheet, RAILWAY MACHINERY, June, 1907.

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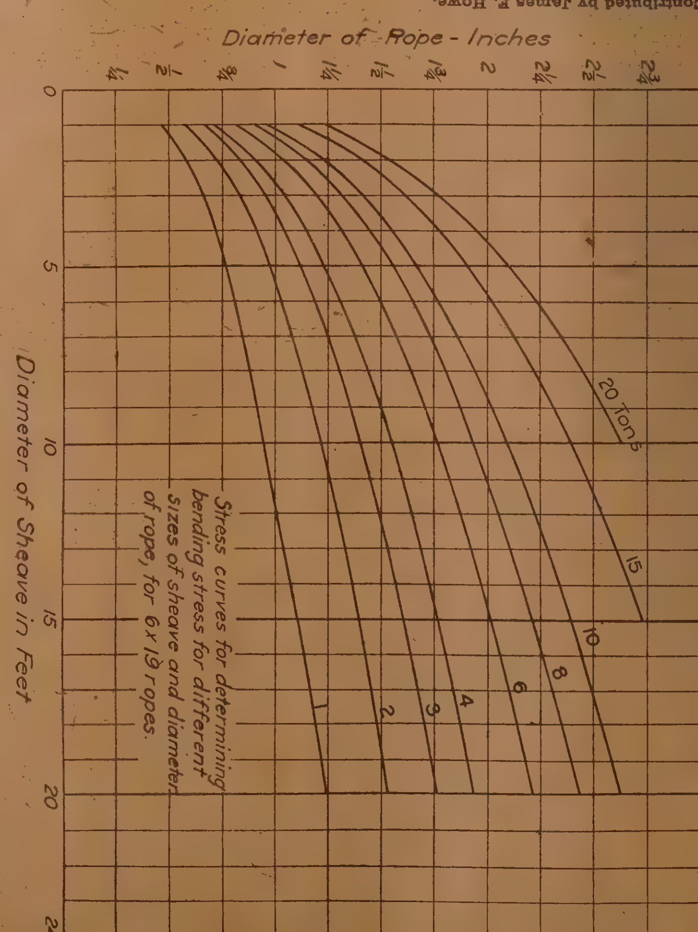
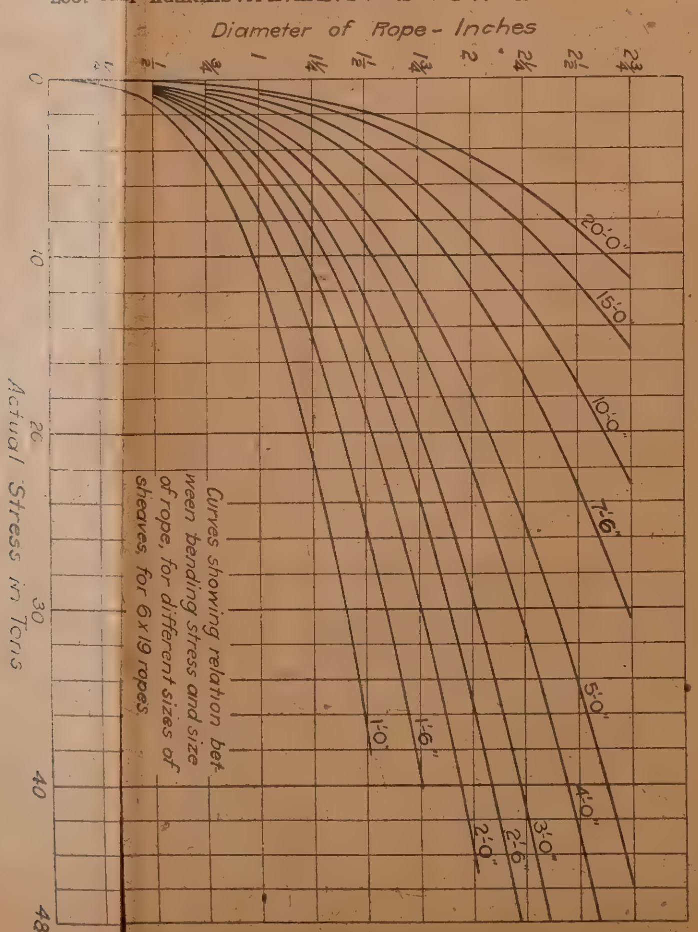
BENDING STRESSES IN WIRE ROPES.—II.

Contributed by James F. Howe.





No. 44, Data Sheet, RAILWAY MACHINERY, June, 1907.

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DATA SHEET.

id for if accepted. Only data not available in handbooks are desired.

This data sheet may be cut into four sections, 6x9 inches in size and bound into note-book form for convenient reference, by means of staples inserted into holes punched at the points indicated.

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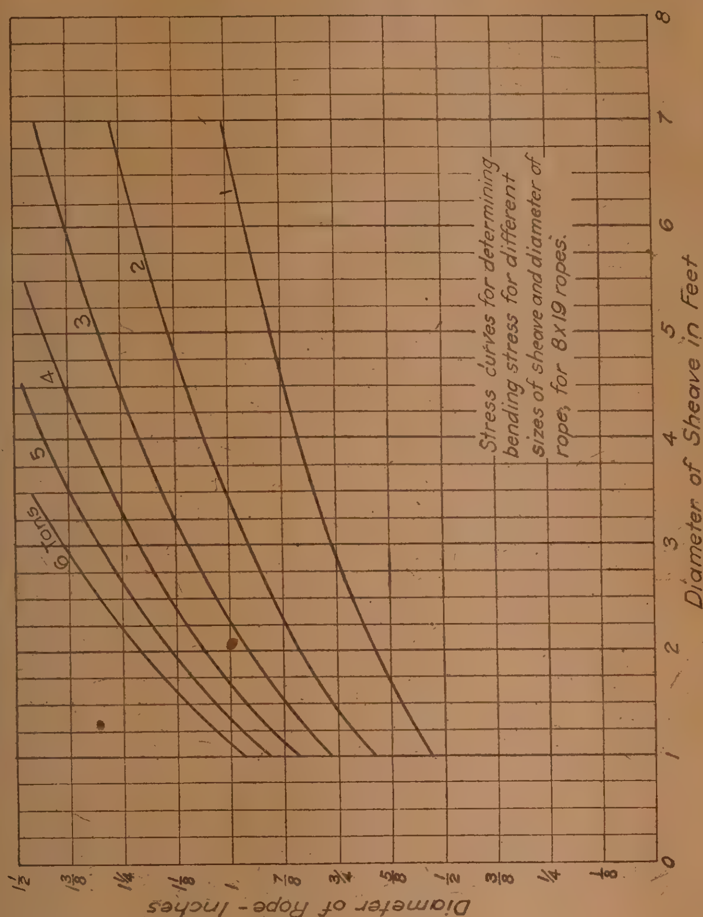
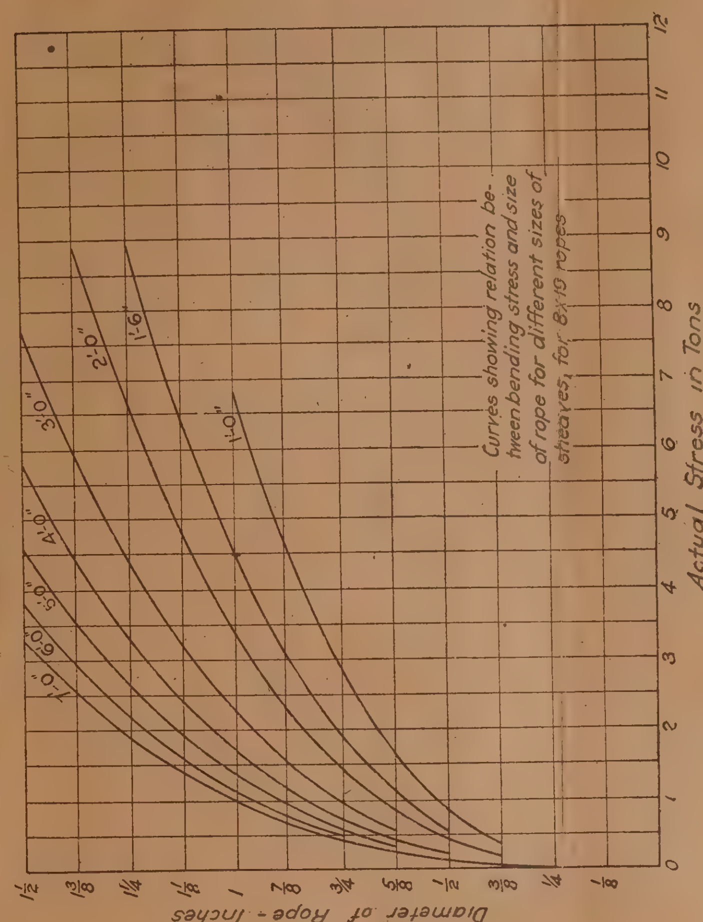
BENDING STRESSES IN WIRE ROPES.—IV.



Contributed by James F. Howe.



No. 44, Data Sheet, RAILWAY MACHINERY, June, 1907.

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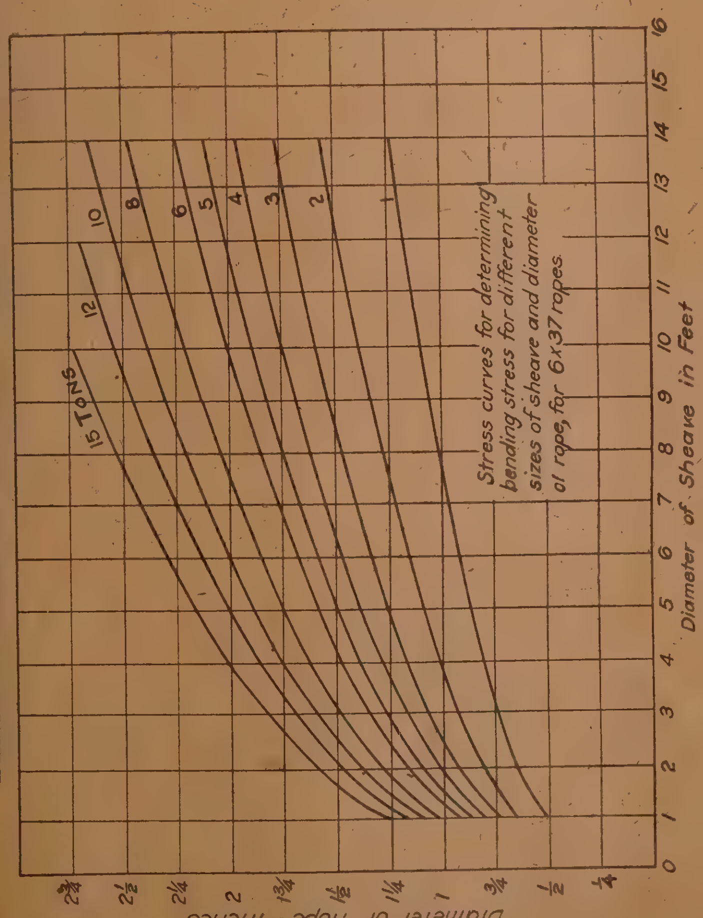
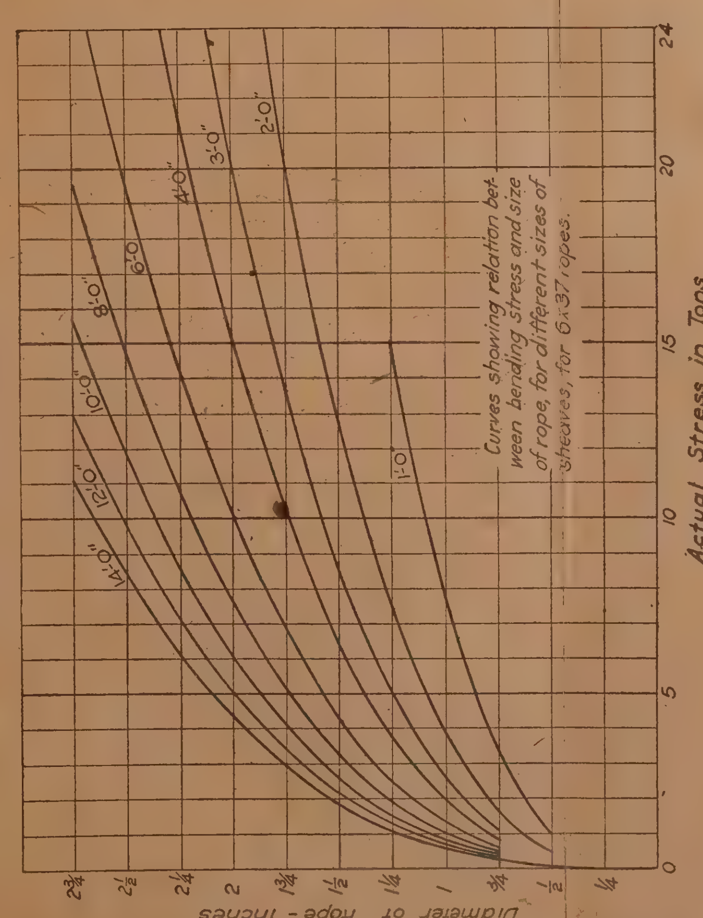
BENDING STRESSES IN WIRE ROPES.—III.



Contributed by James F. Howe



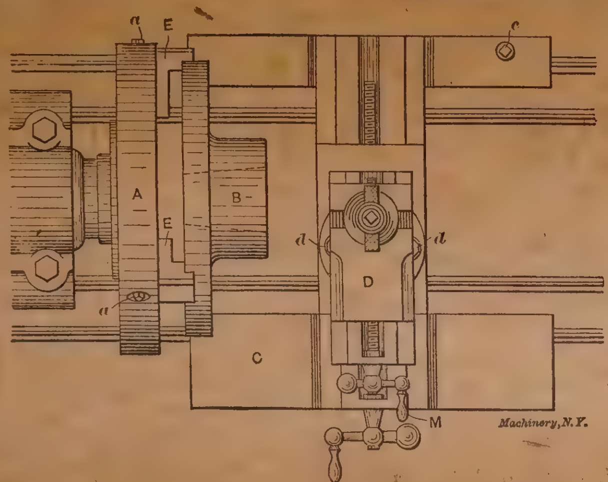
No. 44, Data Sheet, RAILWAY MACHINERY, June, 1907.

PUNCH PUNCH PUNCH PUNCH PUNCH PUNCH.

These operation sheets, covering every class of shop work, are a feature of all Editions of MACHINERY, and appear every month. They may be cut along the top and margin lines for filing and binding. Suitable binders of sufficient capacity to hold four years' issues will be supplied by THE INDUSTRIAL PRESS, 49-55 Lafayette Street, New York, for 25 cents each, including postage.

SHOP OPERATION SHEET NO. 4.

Oscar E. Perrigo. MACHINERY, June, 1907.



To Chuck a Cored Flanged Casting, for Boring and Reaming a Taper Hole.

1. Provide a three-jawed chuck for this job, the screws of which are connected by the usual ring bevel gear within the casing, this form being what is commonly known as a self-centering or "universal" chuck.

2. Put this chuck A on the lathe spindle and screw it up tight against the collar. See that there is no dirt between the collar and chuck face-plate to cause the chuck to run out of true.

3. The jaws E must be turned around so that the steps face inward, as shown in the cut, if they be found in the reversed position required for internal chucking.

4. Put the casting B in the jaws of the chuck, with the large diameter of the cored hole facing the right, and be sure that the piece sits back fairly against the face of the jaws.

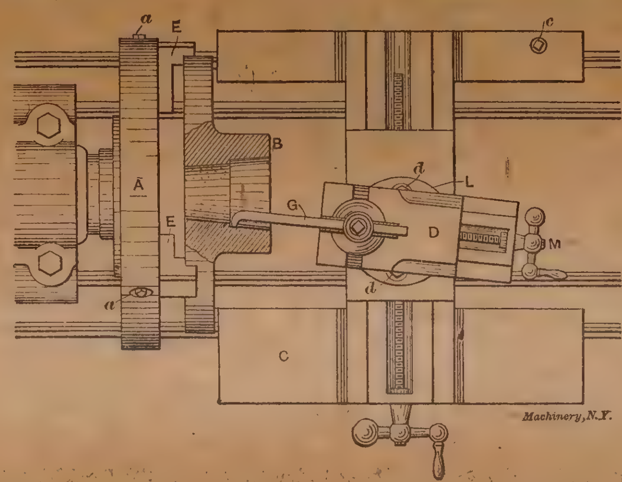
5. Screw up the chuck jaws by applying the chuck wrench to one of the jaw screws a, and successively to the others.

6. Start up the lathe slowly, and by applying a piece of chalk, first to the face and then to the outside of the casting, note whether or not it runs true. If not, there is likely to be a slight unevenness on the casting where it rests against one of the jaws. Loosen the jaws, turn the casting slightly, screw up the jaws, and test as before. Continue this until the casting runs nearly or quite true.

Note.—In some cases it may be required to face the hub of the casting B before it is bored. If this is to be done the lathe carriage C should be brought up somewhat closer than the position shown. Put a right-hand side tool in the tool-post of the compound rest D, set at an angle of about 20 degrees to the face of the hub of the casting, clamp in place, and take a roughing and finishing cut on the face of the hub. This gives a somewhat better condition to start the boring cut, whether especially required or not.

SHOP OPERATION SHEET NO. 5.

Oscar E. Perrigo. MACHINERY, June, 1907.



To Bore Out a Cored Taper Hole for Reaming to a Taper of 6 Degrees with the Center Line, 4 Inches Diameter at Large End.

1. Loosen the clamp nuts d, and swing the compound rest around to the angle of 6 degrees to the center line of the lathe, reading the graduations at L, and clamp in position.

2. Screw the compound rest to the right nearly as far as it will go, so as to have its full travel available for boring. Move the carriage C to such a position on the lathe bed that the front end of the compound rest slide will be a little farther from the casting to be bored than the entire distance through it, and clamp the carriage in position by the screw c.

3. Set a stiff inside boring tool G as shown, and at a little less angle than that of the compound rest, and with its point projecting a little more than the whole depth of the hole to be bored. The height of the cutting edge should be the center of the lathe. Use as large and stiff a tool as possible.

4. Speed the lathe at about 30 revolutions per minute with carbon steel tool, and at 60 revolutions per minute with high-speed steel tool, on cast iron.

5. Proceed to take a roughing cut, using the handle M on the compound rest feed screw for a hand feed. Feed evenly, turning the handle M an equal amount for each revolution of the work.

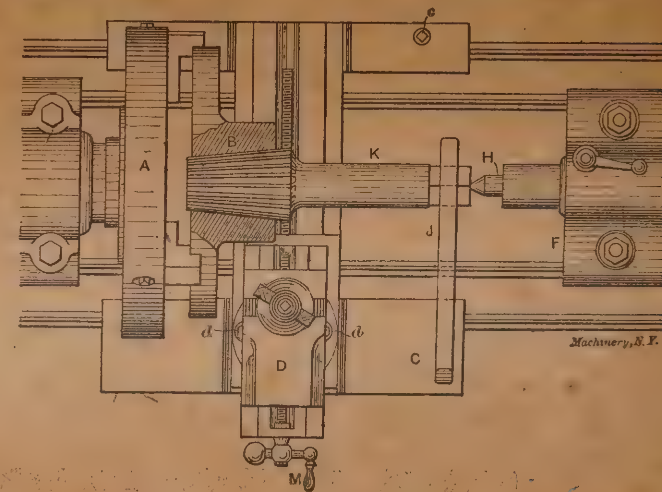
6. To ascertain if the proper angle is obtained, try the reamer into the taper hole. If not correct, adjust the compound rest as found necessary.

7. Make a second roughing cut, enlarging the hole to nearly the diameter for reaming. This cut is usually necessary, because a cored hole is seldom exactly concentric with the outside of the casting. Try the reamer again to see that the proper angle has been obtained.

8. See that the boring tool is sharp and of proper form, and proceed to make a finishing cut, enlarging the hole to about 0.01 inch smaller than the given dimension at large end.

SHOP OPERATION SHEET NO. 6.

Oscar E. Perrigo. MACHINERY, June, 1907.



To Ream a Taper Hole, 4 Inches Diameter at the Large End, in a Bored Casting Held in a Chuck.

1. The casting is supposed to have been bored in a previous operation and to have been truly chucked. Remove the tool from the tool-post, and run the carriage to the position shown.

2. Select a reamer K of the proper diameter and taper, and place it in the taper hole, as shown. Bring forward the tail-stock F and clamp it in proper position, with the tail-spindle center H entering the reamed hole in the rear end of the taper reamer to support it.

3. Upon the squared end of the taper reamer K place the holder or wrench J to prevent it from rotating.

4. Start up the lathe slowly and permit the cutting edges of the reamer to cut, carefully pressing it into the hole by the use of the tail-stock hand-wheel, operated with the right hand, while the left hand steadies the holder J. Raise the holder from its contact with the lathe carriage and exert what resistance may be necessary to prevent it from turning, and at the same time "feel" whether it is cutting properly or not.

5. As soon as the cutting edges have come to a good cutting contact, remove the reamer, stop the lathe, and caliper the large end of the hole, remembering that a taper reamer is liable to enlarge the hole very rapidly.

6. Repeat this operation of reaming a little and then measuring until the proper diameter is obtained. Mark reamer when proper depth has been reached if more holes of same size are to be reamed.

Note.—When many like pieces are to be bored and reamed, it is customary to provide a hardened and ground taper plug as a gage, a mark having been made upon it to indicate the extent to which it must enter the hole to determine the standard diameter. However, when only one or a few pieces are to be bored and reamed, it is customary to give the dimension of the large end of the hole on the drawing.

RAILWAY MACHINERY.

A special edition of MACHINERY devoted to Locomotive and Car Equipment and Mechanics.

July, 1907.

ALTOONA LOCOMOTIVE TESTING PLANT, PENNSYLVANIA RAILROAD.

SINCE November 19, 1906, the locomotive testing plant at Altoona, Pa., has been in continuous operation, and the force of sixteen men have made on an average about three complete tests each week. Certain portions of the apparatus were temporarily installed at the Louisiana Purchase Exposition,* and experience gained through operation there has been embodied in the plant at Altoona.

A separate building of steel and brick has been erected for housing the apparatus. The general appearance of the building is shown in Fig. 2, which also indicates clearly the coal handling arrangement outside of it, with the bin for ashes directly over the track used for bringing in coal.

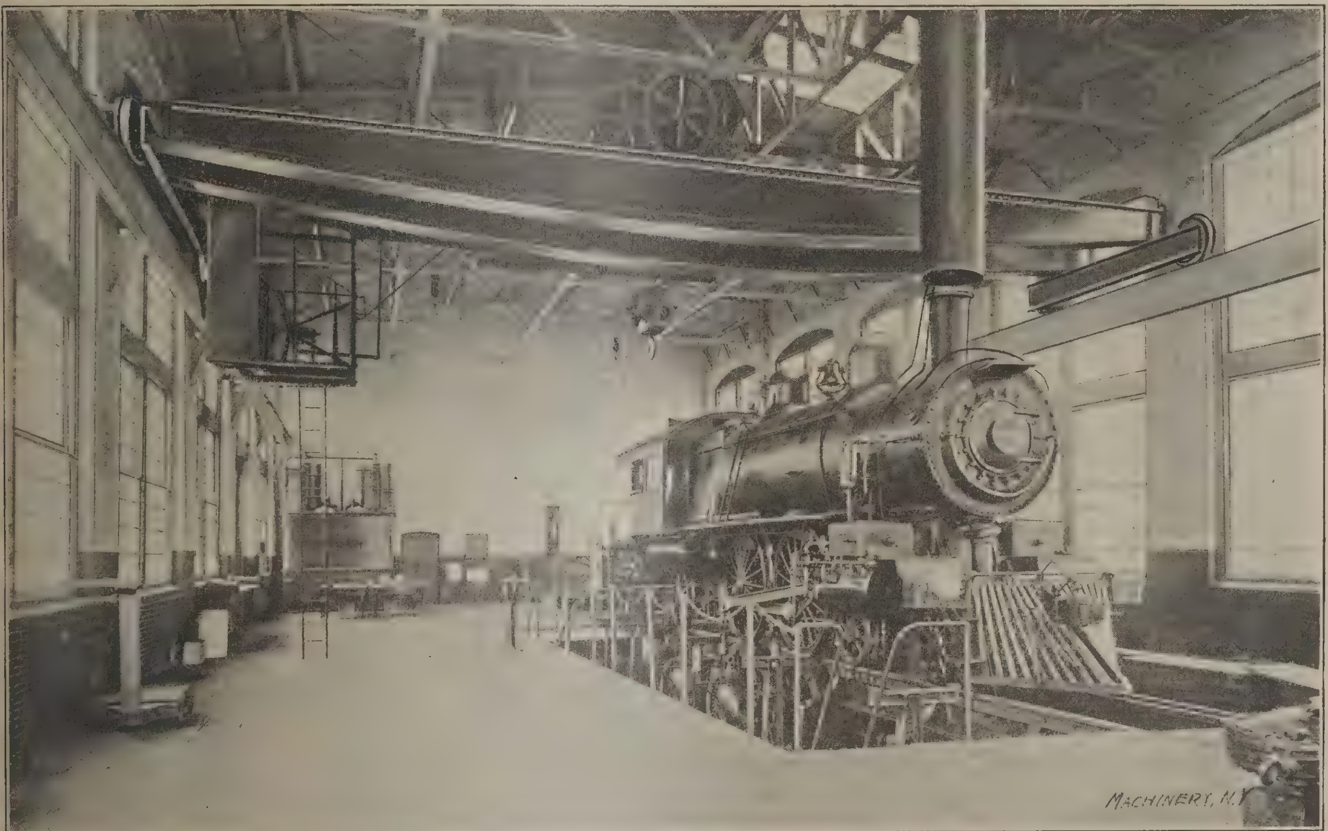


Fig. 1. Interior of Altoona Testing Plant, showing Traveling Crane, Locomotive on Testing Pit, Etc.

The interior arrangement of the plant is shown in Fig. 1. The floor of the laboratory is on the track level and is made in sections, which can be removed by the traveling crane. The space below the removable floor is used for storing absorption brakes, supporting wheels, and other parts, when not in use. On the same level as the storage space, and below the main floor, is all the apparatus for water supply used in controlling the brakes.

The driving wheels of the locomotive under test rest upon supporting wheels with rims shaped to correspond with the head of the rail. See Fig. 3. The axles of these supporting wheels are extended and carry absorption brakes. The turning of the driving wheels causes the supporting wheels to revolve, but these may be retarded to any extent desired. The work actually done by the locomotive consists in overcoming the friction resistance of the supporting wheels and brakes, the resulting force exerted at the drawbar being measured by a traction dynamometer. The axles of the supporting wheels run in heavy pedestals secured to cast iron bed-plates resting upon a concrete foundation. There are two bed-plates running parallel with the track, and in order that the supporting wheels may be directly beneath the locomotive drivers, these bed-plates are provided with T-slots, so that the pedestals can be moved along parallel to the track and secured in any position to suit the particular engine under test. The only wheels of the locomotive which move during a test are the drivers. The wheels of the leading truck rest upon rails secured to I-beams and supported upon the same bed-plates which carry the pedestals. The wheels of the trailing truck rest upon supporting wheels (which remain stationary during the test) and are carried by pedestals secured to the longitudinal bed-plates.

When preparing the plant to receive a locomotive, the pedestals are carefully bolted to the bed-plates, and so spaced that there will be a pair of supporting wheels directly beneath each pair of drivers of the locomotive. A section of special rail is next bolted to the inside faces of the supporting wheels. This rail is composed of a heavy I-beam to the top of which is secured a grooved head in which the flanges of the drivers run. The tops of the supporting wheels are in line with the track entering the building, so that a locomotive can be backed in and the drivers will run on their flanges until in a position directly over their supporting wheels. After a locomotive has been secured in place, and its drawbar attached to the dynamometer, these grooved rails upon which it ran in are removed, leaving the drivers resting upon the supporting wheels.

The axle for each pair of supporting wheels carries upon

* See RAILWAY MACHINERY, June, 1904.

each of its over-hung ends an Alden absorption brake. See Fig. 3. Each of these brakes consists of two smooth circular cast iron disks, keyed to the supporting wheel axle. On each side of each one of these disks is a thin, copper diaphragm secured at its periphery, and also at its inner edge, to a housing which does not revolve and which has its bearing upon the water is caused to flow through the housing in order to carry away the heat generated. The water thus performs two functions: First, in supplying pressure to cause the friction, and second, in carrying away the heat generated by the friction.

Each brake is connected with the source of water supply by

Fig. 2. Exterior View of Altoona Locomotive Testing Plant, Pennsylvania Railroad.

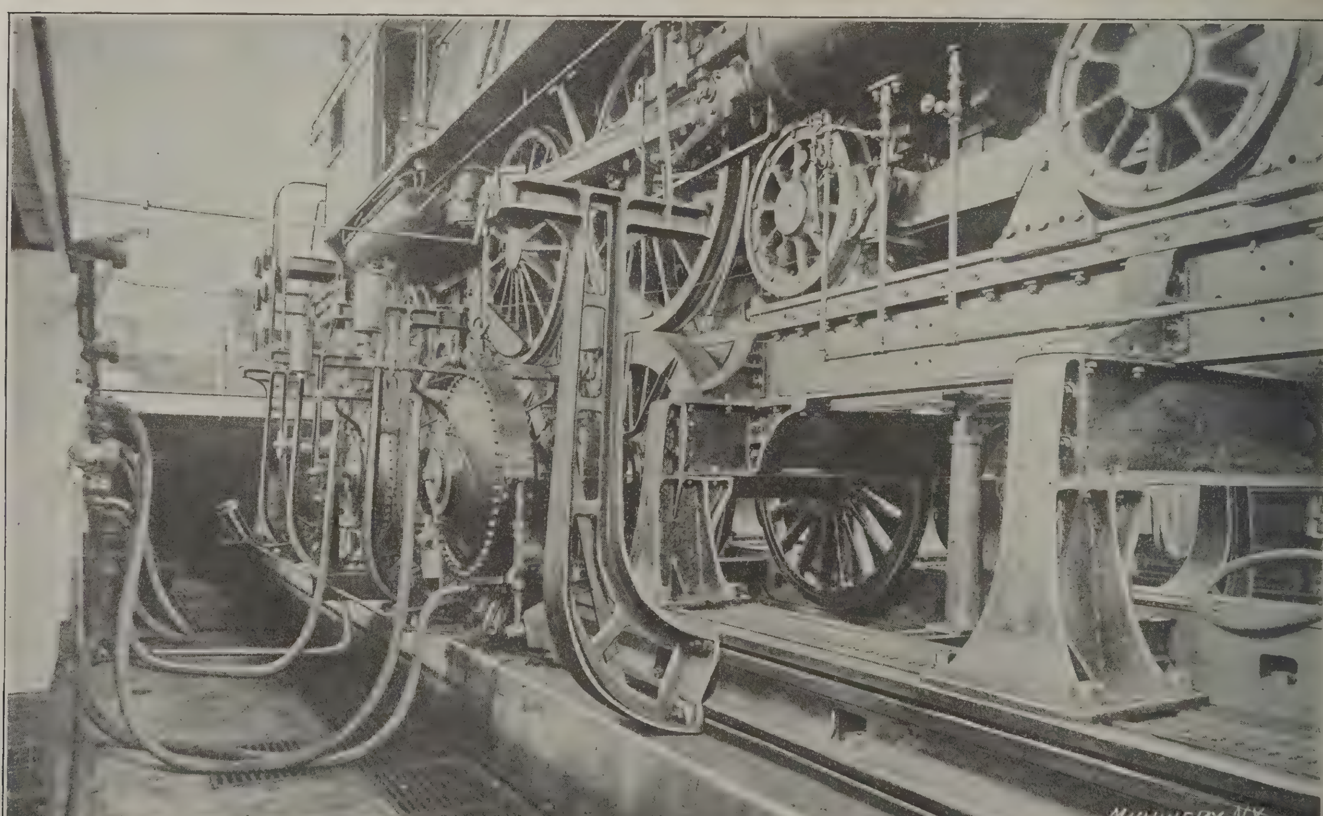


Fig. 3. Showing Alden Absorption Dynamometers, Supporting Wheels, Etc.

the hubs of the revolving disks. This stationary housing is so designed that when it is filled with water under pressure, the copper disks are forced against the revolving disks, creating friction. Provision is made for securing continuous and uniform lubrication of the surfaces of these revolving disks, and

a flexible hose. It is also connected with the discharge pipes by another flexible hose. The discharge pipes for all the brakes empty into an iron trough shown in Fig. 4, and each pipe is provided with a valve located adjacent to the valve in the supply pipe for the same brake. In placing the load upon the lo-

comotive, these valves are adjusted until each of the individual brakes absorbs its share of the work. After this preliminary adjustment has been secured the power absorbed by all of the brakes may be increased or decreased by operating a large valve in the supply main.

In order to secure water under uniform pressure for use in the brakes a special system has been installed. An elevated tank is located near the testing plant building and a two-stage centrifugal pump, driven by a 75-horse-power electric motor, delivers the water under a constant pressure of 75 pounds per square inch to the main header, from which branch the pipes leading to the individual brakes. The water discharged from the brakes empties into the iron trough shown in Fig. 4, and from there runs by gravity into a tank located beneath the floor of the building. Water from this intermediate tank is forced back into the outside supply tank by a centrifugal pump driven by a 20-horse-power electric motor. The outside supply tank is regularly used by locomotives going to and from a roundhouse in the vicinity, so that the warm water returning to the tank from the testing plant is not wasted and does not increase the temperature of the water to an appreciable extent. The entire water system is designed to permit of supplying a large volume of water at low pressure when running high speed tests, and the apparatus is capable of delivering 900 gallons of water per minute.

The locomotive is connected to the dynamometer by an adjustable drawbar, and the dynamometer housing is provided with means for raising and lowering the dynamometer proper

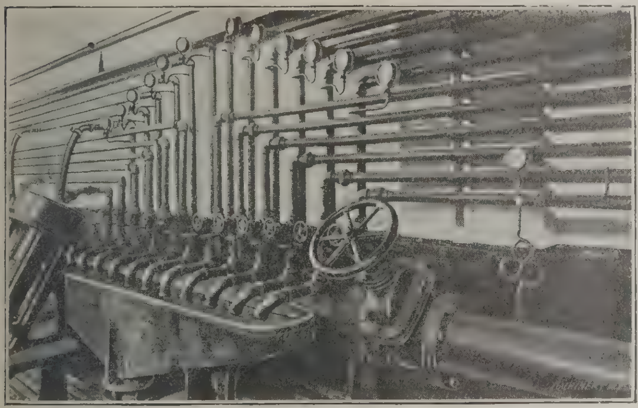


Fig. 4. Piping Arrangement for Absorption Brakes.

to bring this drawbar truly horizontal for various heights of locomotive drawbar attachments in the tail-piece, varying from 30 to 42 inches above the track. To decrease the vibration transmitted to the dynamometer through the drawbar, two safety bars are provided between the locomotive and the dynamometer frame. At their ends these bars have universal joints to insure perfect freedom of adjustment, and each bar is provided with an oil dash-pot near the dynamometer end. The dash-pots are in the form of double disks ground to fit their cylinders closely, and supplied with oil from founts. Their resistance to motion is adjustable by means of by-pass valves in their castings.

The traction dynamometer, which measures the drawbar pull of the locomotive, is of the lever type. The weighing mechanism is supported by a frame which slides up and down in ways formed by the housings. These housings are very massive, rigidly secured together, and anchored to a heavy foundation. The lever system is constructed upon the Emery principle, in which flexible steel fulcrum plates take the place of knife edges used in ordinary scales. As the levers are vertical, instead of horizontal, their weight would not come upon the flexible fulcrum plates in the direction in which they transmit pressure. It has therefore been necessary, in certain cases, to supply two fulcrum plates with their axes at right angles, one for carrying the weight of the levers, and the other for transmitting the thrust.

* * *

Will the correspondent from Pittsburg, Pa., who asked certain questions in regard to the shop operation sheets, kindly send his name and address? The information will be held strictly confidential.

ATLANTIC CITY CONVENTION OF THE A. R. M. M. AND M. C. B. ASSOCIATIONS.

The fortieth annual convention of the American Railway Master Mechanics' Association was held at Atlantic City, N. J., June 12, 13 and 14, inclusive. The meeting was opened by President John F. Deems. After finishing business, reports on "Mechanical Stokers," "Shrinkage Allowance for Tires" and "Locomotive Lubrication" were read. Then followed topical discussions on "Apprenticeship System on the New York Central Lines," opened by Mr. C. W. Cross. Mr. A. Lovell followed with an individual paper on "Shop Cost Systems."

On Thursday, reports were made on "Results of Use of Different Valve Gears," "Proper Spacing of Flues in High-Pressure Boilers," "Blanks for Reporting Work on Engines Undergoing Repairs," "Development of Motor Cars for Light Passenger Service," "Proper Width of Track on Curves, to Secure Best Results with Engines of Different Lengths of Rigid Wheel Base." The topical discussions were: "Is it desirable to eliminate water-gage glasses on locomotives to enforce the use of gage-cocks?" opened by Mr. F. F. Gaines, and "Relative merits of outside and inside delivery pipes in connecting with locomotive injectors," opened by Mr. Strickland L. Kneass. The meeting was concluded by an individual paper by Mr. M. E. Wells, "Cause of Leaky Flues."

The closing session on Friday included discussion of reports on "Superheating," "History of Movement of Locomotives at Terminals," and an individual paper, "Locomotive Failures," by Mr. W. E. Dunham. The topical discussions were: "The corrugated tube for locomotive service, with the view of bringing out the reasons and advantages for its use," and "What is the best metal for hub liners for driving and engine truck wheels, the best method of applying, and the limiting lateral hub play for such wheels before repairs are required?" opened by Mr. J. F. Dunn.

Mr. William McIntosh, superintendent of motive power of the Central Railroad of New Jersey, was elected president for the coming year.

The Master Car Builders' Association held its forty-first annual convention beginning June 17 and closing June 19. Mr. W. E. Fowler of the Canadian Pacific was the presiding officer.

The reports and topical discussions and papers included: "Standards and Recommended Practise," "Up-to-date Cleaning of Passenger Equipment," opened by Mr. P. H. Peck; "Passenger Car Ventilation," opened by Mr. Wm. McIntosh; "Triple Valve Tests," "Brake-Shoe Tests."

"Tests of M. C. B. Couplers," "Revisions of Rules for Loading Long Materials," "Rules for Interchange, including Report of Arbitration Committee on Revision of Freight and Passenger Car Rules and Prices for Repairs of Steel Cars," "Cast Iron Wheels," "Solid Steel Wheels for Passenger Cars," "Freight Car Repair Shop for Winter Work," "Arch Bars for 80,000-pound Capacity Cars," "Air Brake Hose Specifications; Chemical Analysis of Hose."

"High-Speed Brakes," "Height of Brake Staff," "Automatic Connectors," "Tank Cars," "Stress to Which Wheels for 100,000-pound Capacity Cars are Subjected," "Clearance for Lateral Equipment," "Lateral Coupler Clearances," "Truck Springs on Journal Boxes Rather Than Under Bolster."

Mr. George N. Dow, general mechanical inspector, Lake Shore & Michigan Southern R. R., was elected president of the association.

Exhibitors at the Convention.

The following is a partial list of the 254 concerns represented at the Atlantic City convention, the names chosen being those exhibiting products of the most interest to the machine shop:

American File Sharpening Co., New York. Sand-blast machine for sharpening files.

Armstrong Bros. Tool Co., Chicago, Ill. Armstrong lathe and planer tool-holders, and other tools for the machine shop.

Baldwin Steel Co., New York. "Hudson" high-speed steel, milling cutters, reamers, twist drills, lathe tools, etc.

Besly & Co., Chas. H., Chicago, Ill. Spiral disk grinders, taps, oil, oil-cups, babbitt, spiral groove grinding disks, etc.

Best American Calorific Co., W. N., New York. Oil-burning furnaces and oil-burners.

Bethlehem Steel Co., South Bethlehem, Pa. High-speed steel, drop forgings, stay-bolt iron, special high-grade alloy steels of great tensile strength.

Bickford Drill & Tool Co., Cincinnati, Ohio. Radial drill fitted with variable-speed motor.

Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa. Wagner universal cold saw and Jackson belt-lacing machine.

Boker & Co., Hermann, New York. Samples of "Novo" steel, showing the new patent sections and "Intra" steel, a new high-speed steel much lower in price than "Novo."

Bridgeport Safety Emery Wheel Co., Bridgeport, Conn. Motor-driven bar- and knife-grinder, motor-driven tool-grinder, and samples of emery-corundum and carbo-alumina wheels.

Bullard Machine Tool Co., Bridgeport, Conn. New 36-inch vertical turret lathe. This company gave away to those interested a handsome souvenir consisting of the Cox slide-rule mentioned in another part of this issue.

Carborundum Co., Niagara Falls, N. Y. Carborundum wheels, and other grinding shapes made from this abrasive.

Celfor Tool Co., Chicago, Ill. This concern is the successor to the Geo. R. Rich Co., and exhibited the Rich high-speed twist and flat drills in operation.

Chicago Pneumatic Tool Co., Chicago, Ill. Franklin air compressor and pneumatic tools for the machine and boiler shop and other industrial plants and purposes.

Cleveland Pneumatic Tool Co., Cleveland, Ohio. Pneumatic hammers, breast drills, etc.

Cling Surface Co., Buffalo, N. Y. Samples of "Cling-Surface" for increasing the transmission power of belts.

Crocker-Wheeler Co., Ampere, N. J. Variable-speed motor in operation.

Crucible Steel Co. of America, Pittsburg, Pa. High-speed steel twist drills, steel forgings, cold-drawn wire rods, etc.

Landis Machine Co., Waynesboro, Pa. Bolt-threading machine and stay-bolt cutter.

Landis Tool Co., Waynesboro, Pa. No. 16 gap grinder and No. 1½ universal grinder.

Lang Co., G. R., Meadville, Pa. T-head clamping bolts for machine tools.

Lodge & Shipley Machine Tool Co., Cincinnati, Ohio. 24-inch x 12-foot all-geared head, standard screw-cutting lathe, driven by a 10-horse-power variable-speed motor.

McConway & Torley Co., Pittsburg, Pa. Freight and passenger car couplers.

Phillips, Lafitte Co., Philadelphia, Pa. Welding plates, tempering and brazing powders.

Phillips, Sons & Co., F. R., Philadelphia, Pa. "Velos" high-speed steel and twist drills made by the Walter Spencer Co., Sheffield, England.

Pittsburg Automatic Vise & Tool Co., Pittsburg, Pa. Double-swivel and single-swivel machinist's vise, pipe vise, wood-worker's vise, etc.

Rockwell Engineering Co., New York. Oil fuel furnaces for brass melting, rivet heating, flue welding, case-hardening, etc.

Sellers & Co., Inc., Wm., Philadelphia, Pa. Injectors for locomotive and stationary boiler feeding.

Shelby Steel Tool Co., Pittsburg, Pa. Steel locomotive bells, seamless tubing for link bushings, and Shelby steel tubing.

Sprague Electric Co., New York. Air-brake hose and other lines of hose covered with flexible steel armor.

Stoever Foundry & Mfg. Co., Myerstown, Pa. Pipe threading and cutting-off machine.

Tate, Jones & Co., Inc., Pittsburg, Pa. Oil-burning furnaces and appliances for railroad shops, etc.

Underwood & Co., H. B., Philadelphia, Pa. Portable boring bar outfit for locomotive cylinders.

Wagenhorst & Co., J. H., Youngstown, Ohio. Electric blue-printing machine.

Fig. 1. Superheated Steam Locomotive, Canadian Pacific Railway.

T. C. Dill Machine Co., Philadelphia, Pa. Fifteen-inch rapid production slotter in operation, demonstrating its ability to take heavy cuts, and showing its range.

Joseph Dixon Crucible Co., Jersey City, N. J. Samples of Dixon graphite products, greases, pencils, etc.

Richard Dudgeon, New York. Hydraulic jacks for railroad use.

Fox Machine Co., Grand Rapids, Mich. Mitering machine for patternmakers and other woodworkers, milling machines, wood trimmers, heavy pipe cutter, core-box machines, etc.

Garvin Machine Co., New York. No. 2 Garvin universal milling machine with new design dividing head, and other machine tool products.

Gisholt Machine Co., Madison, Wis. Photographs of Gisholt turret lathes.

Goldschmidt Thermit Co., New York. Exhibit showing the use of thermit for locomotive repair work.

Greene, Tweed & Co., New York. Reversible ratchet wrenches and other specialties handled by the concern.

Harrington, Son & Co., Edwin, Philadelphia, Pa. Samples of gear hoists, screw hoists and travelers. The company also exhibited a stay-bolt threading machine.

Helwig Mfg. Co., St. Paul, Minn. Pneumatic reversible motors, pneumatic stay-bolt clippers, pneumatic grinders, flue expanders and pneumatic hammers.

Hess-Bright Mfg. Co., Philadelphia, Pa. Samples of the Hess-Bright bearings.

Houghton & Co., E. F., Philadelphia, Pa. Case-hardening materials, lubricating oils, cylinder oils, Marck steam trap, hydraulic packing leathers.

Independent Pneumatic Tool Co., Chicago. Ill. Reversible and non-reversible piston air-drills, wood-boring machines, pneumatic hammers, pneumatic turbine wood saw, etc.

Jenkins Bros., New York. Valves and packing.

Justice & Co., Philip S., Philadelphia, Pa. Hydraulic jacks.

Kent & Co., Edwin R., Chicago, Ill. High-speed tool steel, milling cutters, drill chucks.

Walworth Mfg. Co., Boston, Mass. Stillson pipe wrenches.

Watson-Stillman Co., New York. Hydraulic jacks.

Western Tool & Mfg. Co., Springfield, Ohio. Lathe and planer tools, expanding mandrels, adjustable reamers, etc.

Wilmarth & Morman Co., Grand Rapids, Mich. Yankee twist-drill grinders.

Yale & Towne Mfg. Co., New York. Electric hoists.

* * *

SUPERHEATED STEAM LOCOMOTIVE FOR CANADIAN PACIFIC RAILWAY.

The Locomotive & Machine Company of Montreal, Limited, has recently completed fifteen ten-wheel type locomotives for the Canadian Pacific Railway—one of which is illustrated herewith. These engines are equipped with the Horsey-Vaughan type of superheater, and are especially interesting as representing the use of large cylinders and low boiler pressure in conjunction with superheated steam.

The Canadian Pacific has taken the lead of all other roads in the country in the application of the superheater to locomotives, and the results obtained with superheated steam on this road have done a great deal toward establishing the superheater as a fixture in American locomotive practise.

It is the growing opinion among railroad men that boiler pressures have been increased to a point where boiler repairs and maintenance are out of proportion to the benefit derived, and it will probably develop that one of the greatest economies obtained by the use of superheated steam is a reduction in boiler repairs, as a result of the ability to work with lower steam pressures.

The engines illustrated are practically identical in design with a previous order, also equipped with superheaters, built

by the same company for that road, except for an increase of 1½ inch in the diameter of the cylinders and a reduction of 20 pounds in the boiler pressure. In working order they have a total weight of 192,500 pounds, of which 142,500 pounds is carried on the driving wheels. The cylinders are 22½ inches in diameter by 28 inches stroke, and with driving-wheels 63 inches in diameter and a working pressure of 180 pounds, the engines have a theoretical tractive power of 34,410 pounds.

The boiler is of the wagon-top type, the outside diameter of the first and smallest course being 70⅜ inches. It is fitted with 240 boiler tubes, 2 inches diameter, and 24 superheater fire tubes, 5 inches outside diameter. The total heating surface is 2,403 square feet, of which the tubes contribute 2,237 square feet and the firebox the remainder. The firebox is 102⅛ inches long and 69⅞ inches wide, and has a grate area of 50 square feet.

The superheater, as mentioned above, is of the Horsey-Vaughan type, which has been applied with very successful results on the Canadian Pacific road, high degrees of superheat having been obtained. The characteristics of the design are, briefly: two independent headers with fingers cast integral, one located in the top of the smoke-box with fingers extended downward for saturated steam, and one just below the center of the smoke-box with fingers extended upward for superheated steam, the fingers being arranged in alternate rows for connection to the superheater pipes, which project into the 5-inch fire tubes. A number of the usual boiler tubes in the upper part of the boiler are replaced by large fire tubes, 5 inches outside diameter, there being 24 such tubes in this design. Each large tube contains four small superheater tubes 1¼ inch outside diameter, connected in pairs at the back end by cast steel return bends. Each pair of small tubes is connected at the front end with the saturated and superheated headers by means of union nuts and special cast wheel fittings which screw into the headers.

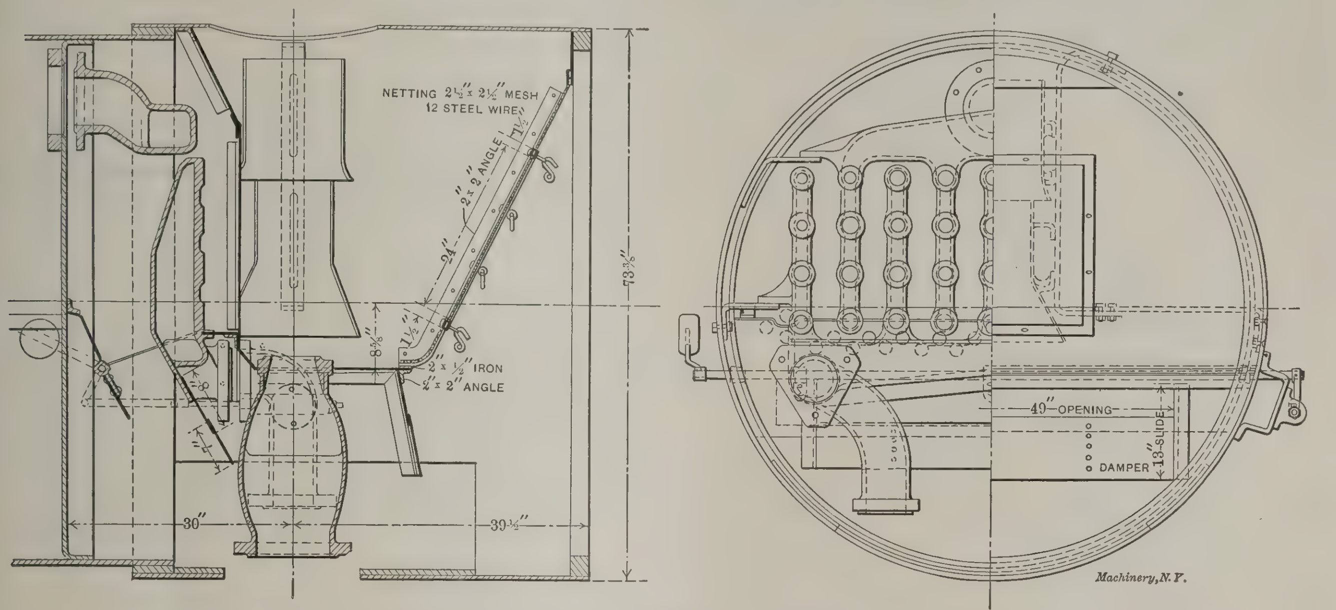


Fig. 2. Smoke-box Arrangement of Superheater.

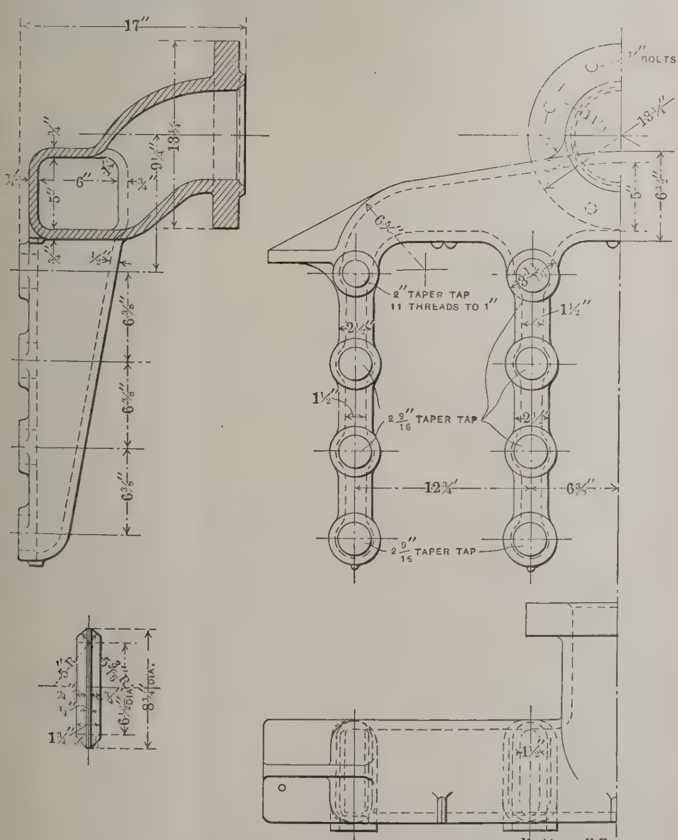


Fig. 3. Top Header of Superheater.

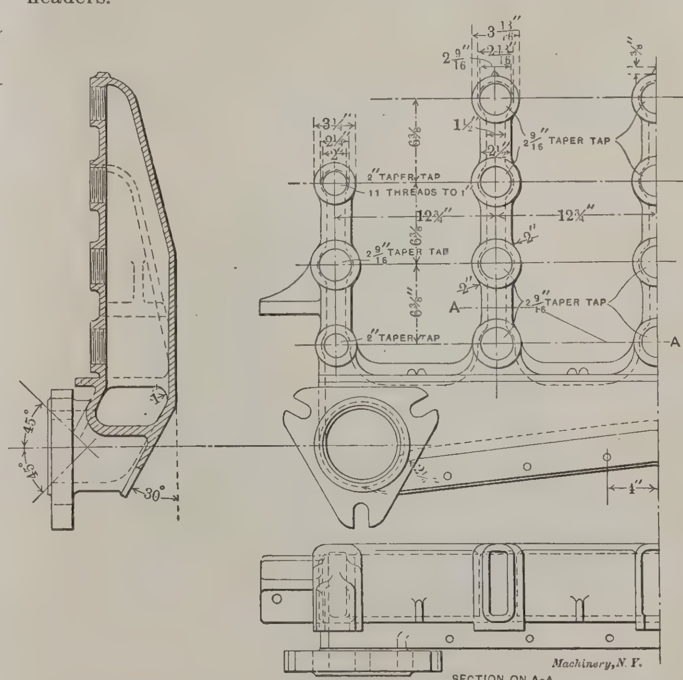


Fig. 4. Bottom Header of Superheater.

An order of fifteen engines for this road, built at the same time and exact duplicates of the ones illustrated, had a working pressure of 175 pounds, instead of 180 pounds.

Specifications of the Canadian Pacific Railway Superheater Locomotive.

Cylinder, simple piston valve; diameter, 22½ inches; stroke, 28 inches; piston-rod diameter, 3¾ inches; piston packing, cast iron rings. Valves, type, piston; diameter 11 inches; travel, 6 inches; steam lap, ⅞ inch; clearance, ⅛ inch; setting, line and line in full gear, front and back.

Gage, 4 feet 8½ inches; wheel-base, driving, 14 feet 10 inches; rigid, 14 feet 10 inches; total, 26 feet 1 inch; total, engine and tender, 54 feet 6½ inches.

Weight in working order, engine, 192,520 pounds; on drivers, 142,560 pounds; total, engine and tender, 318,880 pounds; tractive power, 34,410 pounds.

Axles, driving journals, main, 9½ x 12 inches; others, 9 x 12 inches; engine truck journals, diameter, 6 inches; length, 10 inches; tender truck journals, diameter, 5½ inches; length, 10 inches.

Boxes, driving, main, cast steel; others, cast steel.

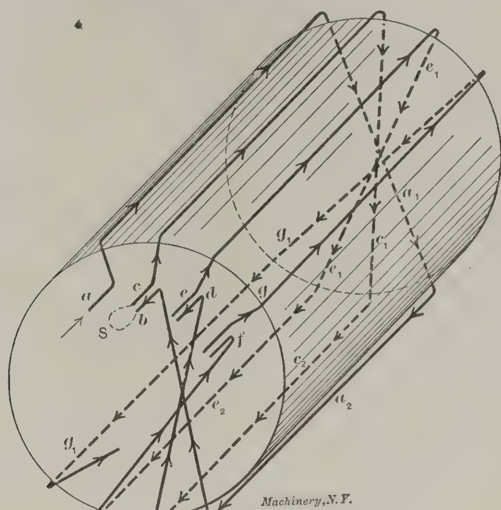


Fig. 34. Winding of Drum Armature.

Boiler, type, extension wagon top; outside diameter first ring, 70⅜ inches; working pressure, 180 pounds; fuel, bituminous coal.

Heating surface, tubes 2,237 square feet; firebox, 166 square feet; total, 2,403 square feet.

Firebox, type, wide over frames; length, 102⅛ inches; width, 69⅞ inches.

Grate, area, 50 square feet; style, cast iron rocking, Canadian Pacific Railway. Thickness of crown, ⅜ inch; tube sheet, ½ inch; sides, 5-16 inch; back, ⅜ inch.

Water space, front, 5 inches; sides, 4½ inches; back, 3½ inches. Crown staying, radial.

Tubes, number, 240; diameter, 2 inches; superheater tubes, 24, 5-inch Mannesman steel; length 14 feet 4 inches; gage No. 11 B. W. G. Engines equipped with Vaughan-Horsey superheater.

Exhaust pipe, cast iron, single C. P. Ry. style.

Smokestack, diameter, top 16½ inches; choke, 14½ inches; top above rail 15 feet 2 inches.

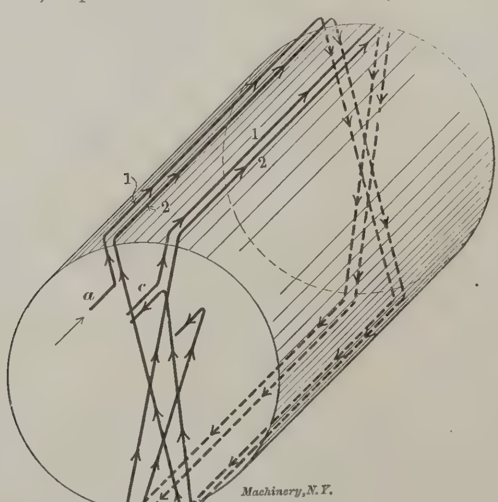


Fig. 35. Winding of Drum Armature.

Brake, Westinghouse-American combination, automatic and straight air; tender, Westinghouse; air signal, Westinghouse schedule J; pump, 11 inches, left-hand; reservoir, one, 22½ inches by 140 inches.

Tender frame, C. P. Ry. standard 10 and 13-inch channel; tank, style, C. P. Ry. standard semi-water bottom; capacity, 5,000 Imperial gallons; fuel capacity, 10 tons.

Wheels, driving diameter outside tire, 63 inches; center diameter, 56 inches; material, main, cast steel; others, cast steel; engine truck, diameter, 31 inches; kind, cast steel spoke steel tire; tender truck, diameter, 34 inches Krupp wrought iron disk center, steel tired.

Engine truck, four-wheel, swing center bearing.

ELECTRIC RAILWAY MACHINERY AND APPARATUS.—5.

WM. BAXTER, JR

In the last article we explained the winding of a ring armature, in connection with Fig. 24. This type of armature is the best one with which to begin the explanation of the way in which the wire coils are wound upon armatures, because the winding itself is decidedly simple, and the form of the armature and the wire coils is such that the location and connection of the latter can be shown very clearly in a diagram. In practise, however, ring armatures are seldom seen; in fact, at the present time there are very few, if any, machines made in which they are used. The type of armature universally used is that known as the drum, its name being derived from the form of the iron core upon which the wire coils are wound.

Drum Armatures.

The difference between a ring and a drum armature is that in the former the iron core is ring-shape, and the wire coils are wound close to the surface of the ring, inside as well as outside, as clearly shown in Fig. 24. In the drum armature the core is made in the form of a drum; therefore, there is no center space through which the wire can be passed, but instead, each coil is wound entirely upon the outer surface. If the ring winding diagram, Fig. 24, is examined, it will be

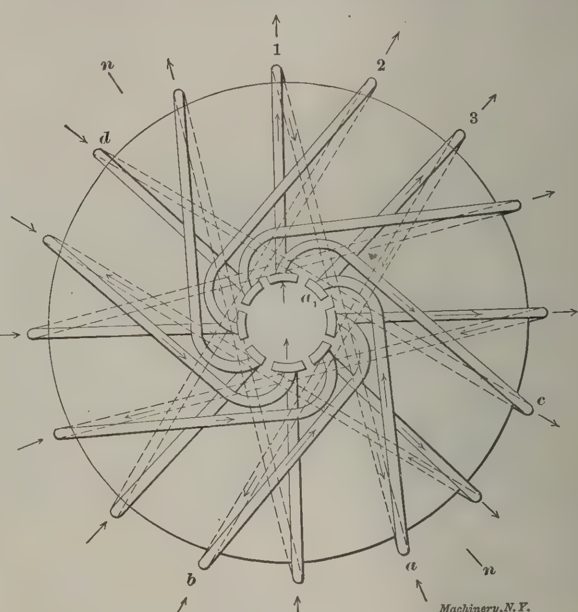


Fig. 36. Winding of Drum Armature.

seen that the direction of the current flowing through the wire on one-half of the ring is directly opposite to that on the other half, so that if any one turn were wound from one side of the ring to the other, instead of passing through the center space, the direction of the current in the two sides of that coil would be just what it should be; but it cannot be seen from this that if all the coils were wound in this way, the current through all of them would flow in the proper direction. Furthermore, it is not very clear just how such coils should be connected so that for all positions of the armature the current entering the commutator through one brush will divide into two parts and each flow through one-half the wire on the armature to reach the opposite brush, as is clearly the case in the ring winding. The way in which a drum armature is wound so as to accomplish this result can be clearly explained by the aid of a few simple diagrams.

The Elementary Principles of Drum Armature Winding.

Fig. 34 illustrates, in a simple form, a drum armature with a few of the coils wound upon it. For the purpose of making the diagram simple, only the iron core is represented, the shaft and commutator being omitted, and the wire coils are shown of one turn each. Starting from a, the wire runs along the surface of the core to the back end and crosses to the opposite side, as shown by line a_1, and returns on the under side, line a_2, and terminates at b. This forms one coil. The end b of this coil and the beginning c of the next coil are

connected with the same segment of the commutator, so that we can form the second coil by simply bending the wire around in a loop as shown at *s*, and thus avoid using separate pieces of wire for each coil. The second coil follows the path $c_1 c_2$ to the end *d*, and this is connected with beginning *e* of the next coil, or we can make a loop as at *s*. The third coil follows the path $e_1 e_2$ to *f*, and then the fourth coil follows path $g\ g_1$, and if the diagram were continued it would join the

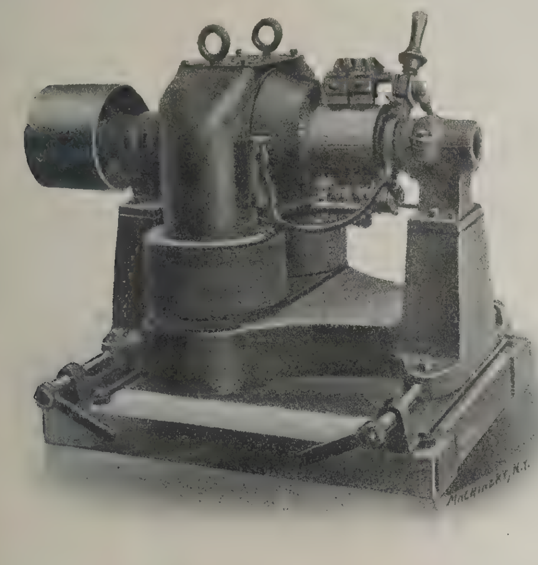


Fig. 37. Crocker-Wheeler Bipolar Motor.

beginning of the fifth coil. In the same manner the end of the fifth coil would be connected with the beginning of the sixth, and so on until all the coils on the armature were wound.

Connecting Coils with Commutator.

The ends of the coils, *b, c, d, e, f, g*, etc., are connected with consecutive commutator segments, each pair with one segment. Looking carefully at the diagram it will be seen that the ends shown will connect with commutator segments that will cover only one-half as much of the circumference as is covered by

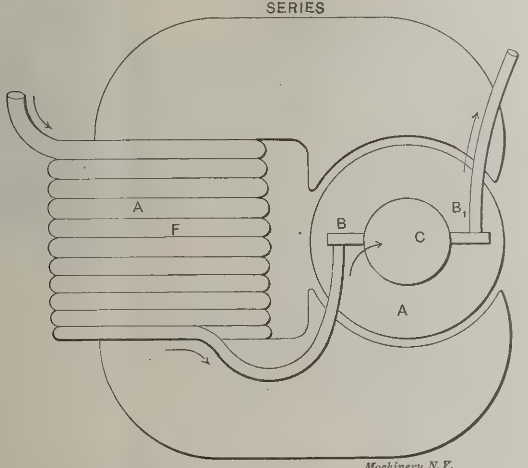


Fig. 38. Series Winding of Bipolar Motor.

the wire coils, for the simple reason that the coils cover an equal amount on both sides of the diameter; therefore, if we continue the winding, we will fill up the surface of the armature core when only one-half the commutator segments are connected. To provide coils to connect with the segments on the other half of the commutator, we wind a second layer of coils on the armature, these being placed in the spaces between the coils already wound. Stating this in another way, the first time we go around the armature, winding coils, we only fill the alternate spaces, and on the second turn, coils are wound in these spaces. The coils of the first turn around the armature connect with the segments on one-half of the commutator, and the coils wound on the second turn are connected with the segments on the other half.

In Fig. 34 each coil is made with only one turn, so as to simplify the diagram, but coils of two or any number of turns can be wound by making as many turns around the armature core as may be desired, and on the last turn the end is brought to the position for connecting with the commutator segment, as is clearly shown in Fig. 35, which illustrates coils of two turns each. Further light is thrown upon the subject by diagram, Fig. 36, which represents an end view of an armature fully wound with eight coils of one turn each, the inner circle representing the commutator. If the current is supposed to enter through the top segment, one-half of it will pass up to coil 1 and the other half will flow to coil *c*. Following both these currents it will be found that after each one has passed through four coils it will reach the lower commutator segment. If the paths of the two branch currents

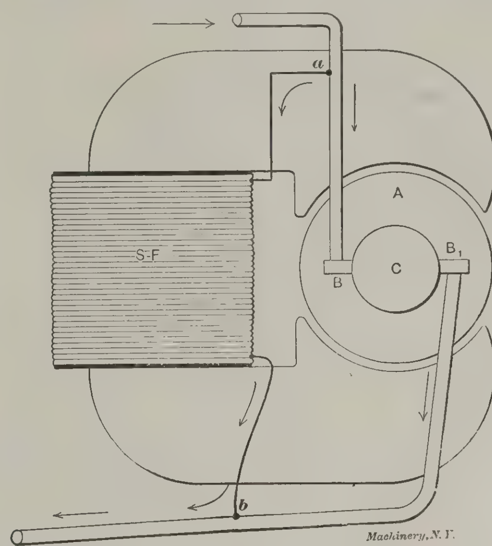


Fig. 39. Shunt Wound Bipolar Motor.

are traced out from any other commutator segment, it will be found that they will be the same as from the top and bottom segments; that is, in every case each current will pass through four coils. It will also be found that on one-half the armature surface, the current will flow from front to back, and on the opposite half the flow will be from back to front, just as in the ring armature.

Type of Machines in which Drum Armatures are Used.

Drum armatures, wound in the manner explained in the foregoing, are used in motors constructed with two poles. Such machines are generally called bipolar motors. Fig. 37 shows a

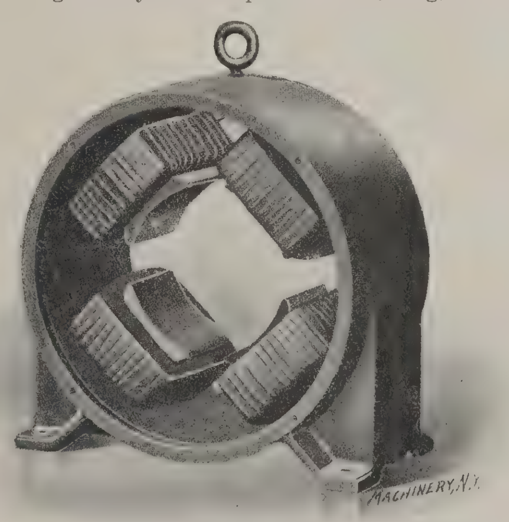


Fig. 40. Four-pole Field.

small stationary motor of this type made by the Crocker-Wheeler Co. These machines, as well as all other types of direct current motors and generators, can have their field coils and armature connected in different ways, with reference to each other and to the external circuit. These different ways of connecting them can be easily explained with the aid of Figs. 38 and 39, which are diagrams of a bipolar machine, illustrating the series and the shunt types of connection. In addition to these two types there are the compound and the differential for motors, and the compound for generators.

Series-connected Motor.

Fig. 38 represents a series-connected motor. It is called by this name because the armature and the field coils are connected in series, so that all the current that passes through the motor flows through both parts. In this diagram the current enters the field coil *A* at the upper end, and passing out of the lower end, goes to brush *B* resting on the commutator. From here the current flows through the armature by two paths, as explained in the foregoing, and reaches brush *B*, from where it flows out to the main line. In some motors, as for instance, Fig. 37, there are two field coils, or even more, and then the current enters through one of these coils, and from the end of this goes to the commutator brush, thence through

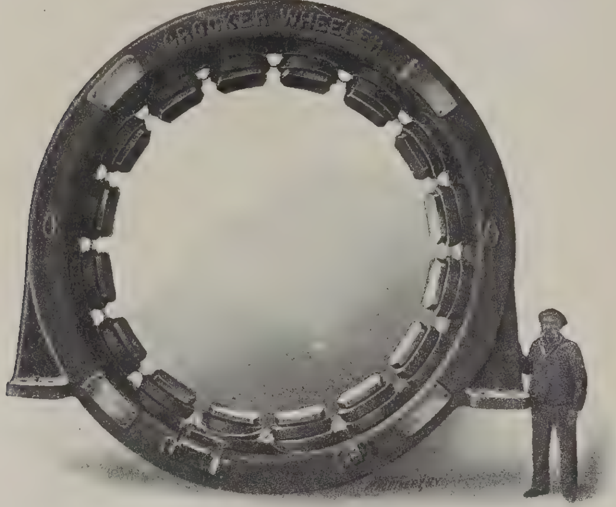


Fig. 41. Crocker-Wheeler Railway Generator.

the armature, as just explained, and from the second commutator brush passes to the second field coil, flowing through the latter and then back to the line. This connection is made simply to balance the construction, mechanically, but the operation is the same as if the current passed through both the field coils first, and then through the armature.

Action of the Series Motor.

The series motor, in running, acts the same as a steam engine without a governor; that is, if the load is light it runs fast, and if the load is heavy it runs slow, and if all the load is thrown off it will run away, provided the current is not immediately cut down, just as the engine will do if the throttle is not immediately closed. There is a difference, however, between the action of the series motor and the engine, which is that the former pulls harder the more it is loaded. For this reason the series motor is admirably adapted for railway service, and is used exclusively in that field. Another feature that makes it adaptable to railway work is that its velocity can be varied through as wide a range as may be desired.

The Shunt-connected Motor.

The diagram, Fig. 39, illustrates a shunt-connected motor. The whole of the current does not, in this case, pass through the field coils as well as through the armature. On the contrary, only a very small portion goes through the field; but to make up for the lack in quantity, the field coils are made of many turns of fine wire. In Fig. 39 the field current is shunted from the armature circuit at *a*, and after passing through the field coil returns to the main circuit at *b*, thus passing around, or shunting, the armature. The current that flows through the field coil is all the way from about one per cent of the whole, in large, highly efficient machines, to four or five per cent in small motors.

Action of the Shunt Motor.

The action of a shunt motor is the same as that of a steam engine provided with a good governor, that is, it runs at a constant speed, or nearly so, regardless of whether the load is light or heavy. Owing to this fact this type of motor is suited for driving machinery of any kind that requires a uniform velocity, but it is not suited to railway service. Shunt motors can be made to run at different speeds by slightly changing the proportions, but the range of speed variation is not sufficient for railway work.

Other Types of Motor Connection.

The compound wound motor is a combination of the series and the shunt winding, that is, it has two sets of field coils, and through one all the current passes, just as in the series machine, and through the other only a small portion, as in the shunt motor. This winding was developed so as to make the motor pull harder, like the series motor, when the load is increased, and at the same time possess the feature of not being able to run away, which is characteristic of the shunt motor. It is principally used for elevator work.

The differential wound motor is provided with series and shunt coils, just like the compound machine, the only difference being that the current flows through the series coils in the reverse direction, so as to act in opposition to the shunt coils. This winding was devised years ago under the belief that it would cause a motor to regulate more closely when running with a variable load, but experience has shown that, if properly designed, the plain shunt motor will run just as well.

Multipolar Machines.

The bipolar type of machine is used at the present time only for small motors. Larger ones and generators are made with four, six, or a greater even number of poles. The reason for using more than two poles will be fully explained hereafter. The appearance of the field of a four-pole machine can be seen in Fig. 40, which is a design that, with small modifications, is used extensively for stationary motors ranging from ten to fifty horse-power. Fig. 41 shows the field frame of a large Crocker-Wheeler 16-pole generator of the type used for railways and power transmission. It is connected directly with a large steam engine, the crank of the latter being mounted on the end of the armature shaft.

Railway Motors.

Railway motors are universally made of the multipolar type, the number of poles being in almost every case four. A Westinghouse railway motor, having four poles, is shown in Fig. 42. These motors are made so that the under half of the

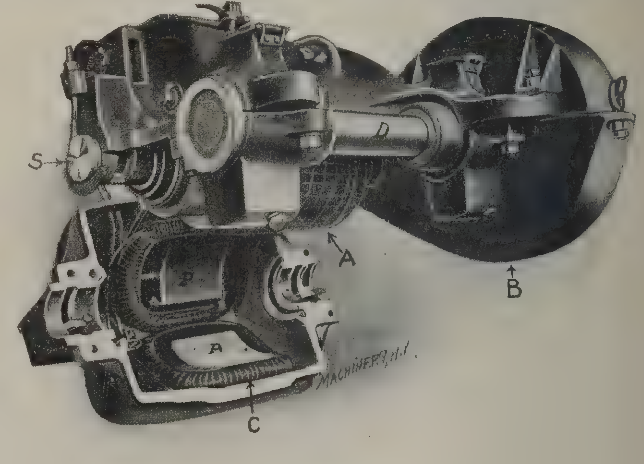


Fig. 42. Westinghouse Railway Motor, with under half Lowered.

field frame may be lowered, so as to permit of easily removing the armature when necessary. The two poles in the lower half of the field frame are seen at *P*. The armature is at *A*, and *B* is the casing within which are the gears that transmit the motion of the armature shaft *S* to the car axle *D*. One of the four field coils is seen at *C*. The mechanical features of this motor are quite clearly shown in the illustration. The electrical portion will be fully explained hereafter.

* * *

The large gas engine is rapidly coming to be an important factor in power development in the United States. One large company has orders for 36 gas engines of 4,000 horse-power each, or an aggregate of 144,000 horse-power; 25 of these great engines go to the new plant of the United States Steel Corporation at Gary, Ind. These engines weigh 1,500,000 pounds apiece, and the entire 36 will require 2,300 freight cars to transport them.

WORKS OF THE LANDIS TOOL CO.

H. F. NOYES.*

One of the younger machine tool manufacturing establishments which has grown rapidly within the past few years, is that of the Landis Tool Co., Waynesboro, Pa., the largest exclusive manufacturers of wet-grinding machinery in this country. This firm manufactures at present only cylindrical grinding machines, ranging in sizes from 10 x 20-inch to 30 x 198-inch, and including about fifty different types; it employs over 450 men, the number of employes having more than doubled within the past three years. The illustration, Fig. 1, shows a general view of the plant, taken from behind the works. Fig. 2 is a ground plan of the property, and the remaining photographs are views taken in the different departments.

Several buildings and a good deal of machinery have been added within the last two years. The older machine shop, which was originally separated from the office building by about 60 feet, has been connected with it, and an addition also put on the other end, making an increase in floor space of about 10,000 square feet. About 2,000 square feet has been added to the foundry, and a separate building erected for the cleaning of castings and storage of the smaller castings, the larger ones being stored out-of-doors, in the yards. The power plant has been rebuilt entirely, as formerly most of the power consumed was obtained from the city.

Shipping facilities are afforded by direct connection with both the Western Maryland R. R. and the Cumberland Valley R. R. Standard gage tracks are laid to both machine shops, to the power plant and to the foundry, and in addition are so arranged as to cover a good portion of the yards used for storage purposes. A locomotive crane is used for transferring heavy work from one point to another. In addition, a narrow gage road connects the foundry, casting cleaning building, pattern-storage house and yards, for handling lighter materials.

Fig. 1. General View of Landis Tool Co.'s Shops, Waynesboro, Pa.

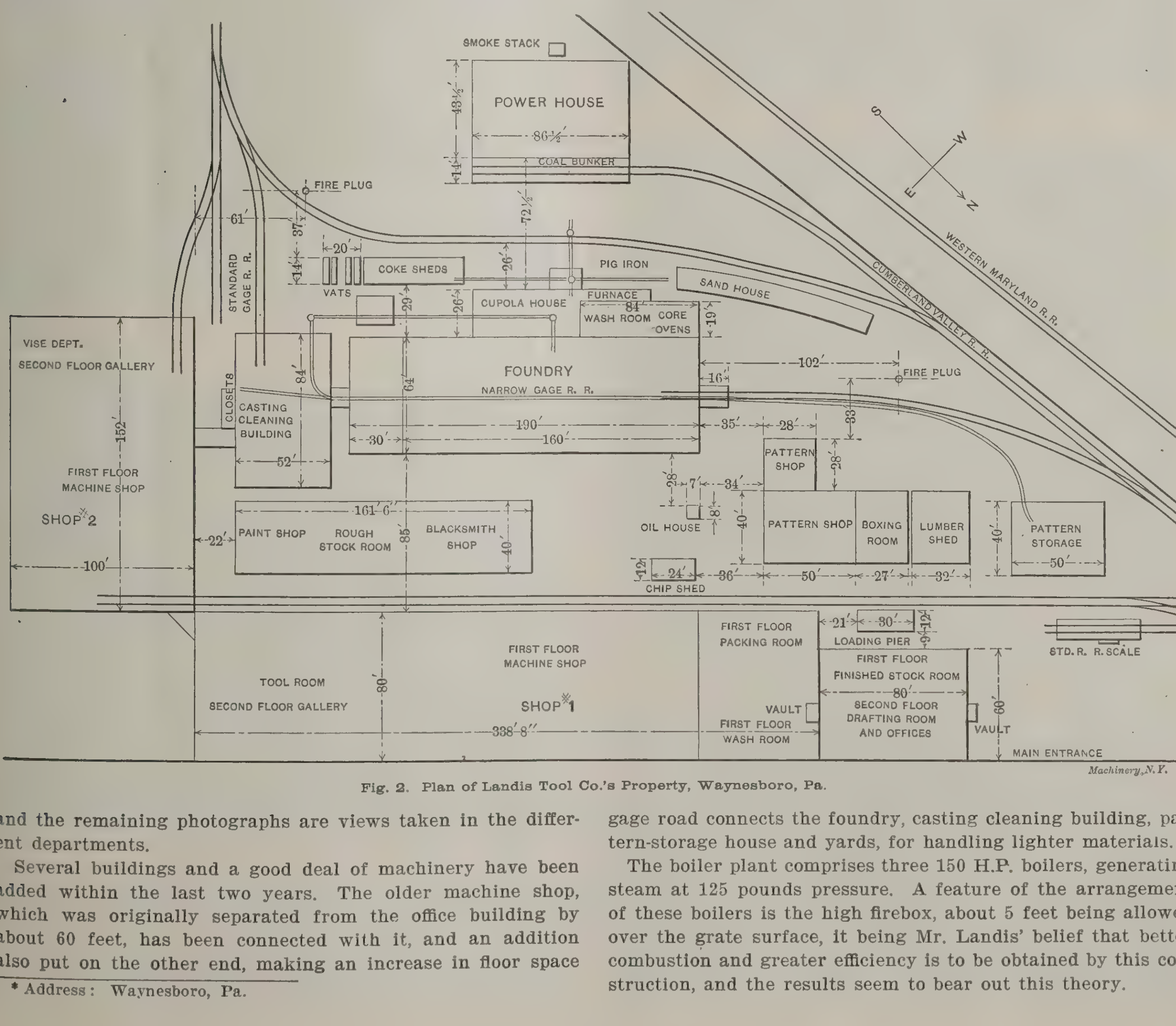


Fig. 2. Plan of Landis Tool Co.'s Property, Waynesboro, Pa.

The boiler plant comprises three 150 H.P. boilers, generating steam at 125 pounds pressure. A feature of the arrangement of these boilers is the high firebox, about 5 feet being allowed over the grate surface, it being Mr. Landis' belief that better combustion and greater efficiency is to be obtained by this construction, and the results seem to bear out this theory.

* Address: Waynesboro, Pa.

Power is obtained from two 300-H.P. direct-connected engines, coupled with two 200-K.W. generators, 220 volts, direct-current. The plant is operated in divisions of 25 to 50 H.P., each comprising a line-shaft driven by a suitable size motor, according to the requirements of the various departments. The larger machines are operated by individual motors.

The buildings are heated throughout by the Sturtevant system of forced hot air circulation, exhaust steam being chiefly used for heating the air.

The foundry is of about 12,000 square feet floor space, the building being of brick and steel construction. The core-room and ovens are arranged at the northwest end of the building. The photograph, Fig. 3, was taken from this end of the building, and gives an interior view taken just as the foundrymen were beginning to pour, and shows at the right a stream of metal issuing from the cupola. An electric crane of 15 tons capacity and 30-foot span covers the entire west side of the

Fig. 3. Foundry, Landis Tool Co.'s Shops.

Fig. 4. Outside View of Foundry.

building, and the lighter work and molding machines are arranged on the other side. The castings are cleaned both by hand and by sand-blast in a separate building.

The property provides ample yard space for the storage of heavy castings, it being the practise to weather all parts where accuracy of form is required, such as beds, as long as possible. Fig. 4 shows a lot of about 100 beds left out to season.

The machining is done in two shops, forming the two parts to an L, one being 338 by 80 feet, and the other 150 by 100 feet. Each is arranged with a gallery at one side, the other side being left clear for operating an electric crane, each crane being of 20 tons capacity. The first floor of shop No. 1 is devoted on the side under the gallery to lighter lathe work, milling, drilling, and grinding. The space under the crane is used for scraping and assembling machines, the scraping being done nearer the southern part of the building, and the parts and machines gradually moving along toward the other end, as they go through the successive steps of assembling and packing.

The gallery above is divided off at one end for the tool-room, and the other end is devoted to automatic screw machines, gear cutters and thread millers. Next to the offices is a room devoted to experimental work.

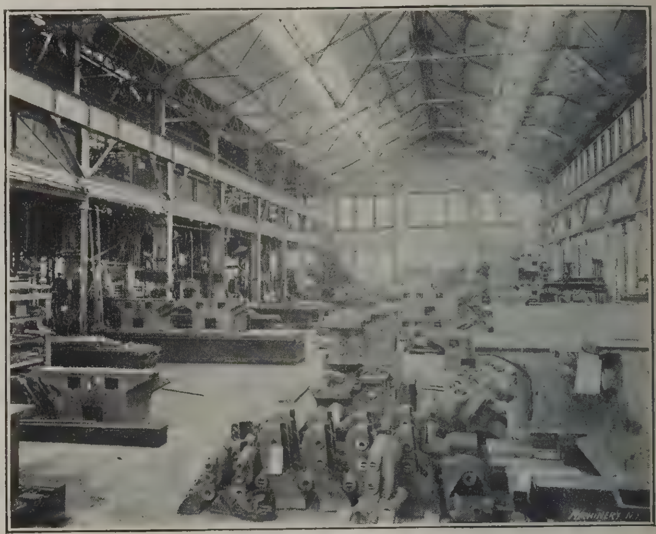


Fig. 5. Planing Department.

Fig. 6. Heavy Lathe Department.

Fig. 7. Grinding Department.

The first floor of shop No. 2 is used for heavy work, the planers being located in a longitudinal line in the middle of the room, at the edge of the space covered by the crane, leaving the main part of the floor beneath clear for heavy parts of machines in process of construction. Beneath the gallery are located heavy lathes and turret lathes, and a vertical boring

mill, and along the wall on the other side of the clear space are several radial drills and a floor-plate boring mill.

This floor is illustrated in two views, Figs. 5 and 6. In the gallery of this building is the vise department arranged for fitting up and assembling smaller mechanisms and parts of machines.

Fig. 8. Grinding Cone Pulleys.

Fig. 9. Tool-room.

Fig. 10. Vise Department.

Another building about 40 x 160 feet is used for the painting, the blacksmith shop, and steel stock-room, and the room under the offices is fitted up for storage of finished stock.

One of the manufacturing methods worthy of note in this shop is the method of planing. All beds, swivel-plates, and carriages are roughed out on one set of planers, and finished on another set, the latter being always kept in perfect alignment and used only for finishing. While this practise necessitates additional handling, it has been found that the saving of time required in scraping to proof-plates is so much decreased as to offset the additional handling many times. It was found that when the same planer was used for both roughing and finishing, it was subjected to such severe strains that it was impossible to keep it in good condition.

As is natural in a shop manufacturing grinders, everything is machine ground, both internally and externally, where there is any advantage to be gained, either in time, accuracy or finish. All bushings are internally ground, most drums are finished by grinding, and some cast iron drums are finished from the rough. The most novel and extensive application of grinding is found in the handling of pulleys. These are practically all crowned and finished on the grinder, two and sometimes three machines being utilized for this work most of the time. Both single and cone pulleys are finished in this manner, some of the former with faces as wide as 4¼ inches. All are finished with a radial crown from 1/16 to ¼ inch larger in diameter at the center than at the edge of the crown, according to the width of the face, the faces having been previously rough-turned to within 1/64 inch of the required size.

Fig. 11. Corner of Drafting Room.

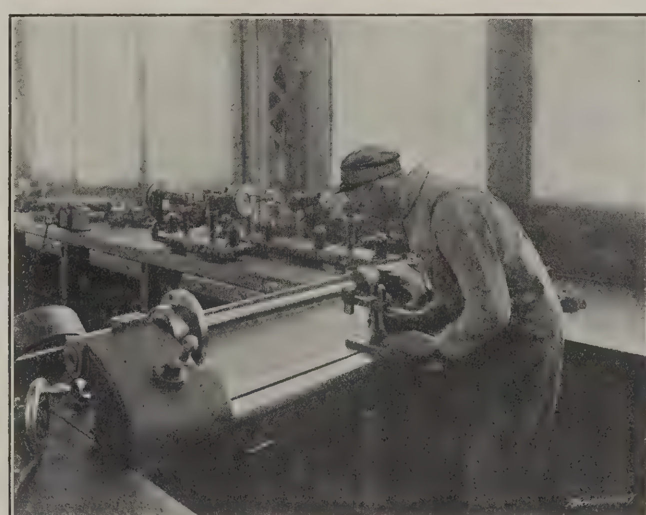


Fig. 12. Lining-up the Tail-stock.

This grinding is accomplished by using a wheel with a width slightly greater than the face of the pulley, and sinking straight in without any traverse of the wheel with relation to the work. The wheel is previously given a concave face of a radius suitable for the pulley to be crowned, by means of a radial truing device which is in position on the machine in the photograph, Fig. 8. This device comprises simply an open box-shaped base, fastened to the swivel table of the grinder, and provided with a number of holes located about 2 inches apart. Pivoted upon this base is a long arm also provided with

a number of holes, and having a diamond set at one end. By changing the location of the pivoting point, any suitable radius may be obtained.

The following figures on this work, taken without any special preparation, and representing average results, will be found interesting to compare with lathe work. A pulley 11 inches diameter, 4¼ inches face, about ⅛ inch crown, roughed out to within 1/64 inch of the required size, was ground in eight minutes, exclusive of the time of putting on mandrel. The work surface speed was about 5 feet, and the wheel speed about 5,000 feet per minute. While this operation required considerable power behind the machine, it was not very much more than that required for crowning on the lathe with a wide-faced tool, and the saving in time more than pays for the little extra power consumed. Another pulley 18 inches diameter by 3 inches face was ground in 7 minutes. A cone pulley of three steps, 17⅛, 16 3-16, and 15 inches diameters, all 3⅛ inches face, was ground complete in 20 minutes.

In all these cases the work was finished on the grinder in the time indicated with a finish plenty good enough for the purposes of a pulley.

In some experimental work done here recently results were obtained which would call for considerable effort on the part of the lathe to compete in the way of roughing out stock. Some cast iron drums 3⅛ inches diameter by 19½ inches long, were rough ground, ⅛ inch being removed in two cuts, once up and back, depth of cut 1/32 inch, on an average of 3 minutes each. This is equivalent to a reduction of about 4 cubic inches of metal per minute, and was exceeded in some cases.

Thus it is plain that the growth of the grinding idea has included work that only a few years ago would have been regarded as purely a lathe operation in all machine shops. The old idea that grinding was to be regarded as a finishing operation, to be used only where great precision was required, was exploded some years ago, but it takes a long time for the idea to become generally accepted. The natural improvement in grinding machinery will likely make these machines still more formidable competitors of other machine tools, as time passes.

* * *

CAST THREAD FITTINGS.

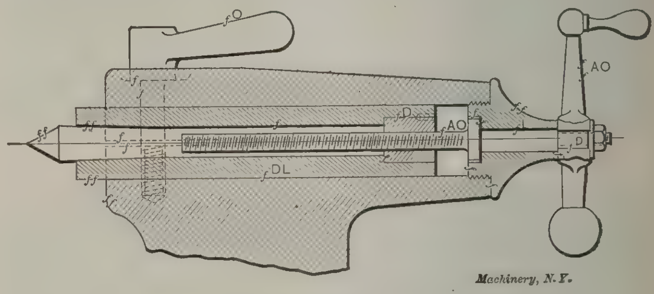
In a paper read at the annual convention of the American Foundrymen's Association held at Philadelphia, Pa., in May, Mr. Henry B. Cutter, of Seneca Falls, N. Y., stated that the principle and method of making gray iron castings with threads cast in them was developed by George Cowing, of Cleveland, Ohio, about 1878. The development of such castings was coincident with that of the pump industry, in which Cowing & Co., Seneca Falls, N. Y., were leading factors. This company employed the method of casting the threads on parts which had to be screwed together, until the practical abandonment of the business. Since the organization of the Cast Thread Fitting and Foundry Co., the idea has been carried to a much higher development. Recent tests made with cast thread fittings screwed together with wrought iron pipe having standard cut threads showed no indication of leak under a pressure of 900 pounds to the square inch, although nothing else than lubricating oil was used on the threads in screwing them together. The method pursued in making these fittings does not involve the use of chills as has been erroneously asserted, but does require the use of seamless sand cores formed without fin or rib as inevitably would be the case if made in sections in a cored box. The threads of these seamless cores are formed in sand by special devices, which cut a thread in the sand. The dies of the thread forming device are made of high grade steel and wear very slowly. When once made to standard gage, they produce thousands of seamless thread cores without appreciable variation in pitch or size, and perfectly round. These seamless thread cores are then joined with the ordinary plain or body cores by arbors, and are placed in the mold the same as ordinary cores. Special iron mixtures and fine sand are employed to produce a clean, sharp thread in the castings. This system has been developed so that the threads and castings which come at opposite ends of the fittings will be in perfect alignment.

INDICATING FINISHED SURFACES.

C. T.

The accompanying line cut shows a simple and convenient system of finishing marks which has been in use for several years. It will be noticed that the usual *f* is the predominating character, with the addition of a small letter at the right, this letter denoting the fit desired in the piece on which it may be placed. This exponent, as it were, has not been chosen so much because it would suggest the character of the fit, but rather for the ease with which it may be made on the drawing, that is, with one stroke of the pen. In the design of special machinery, where the workmen have no past experience to guide them, these marks have saved, to the draftsman, any small and yet important questions as to fit, finish and quality of finish, necessary.

On detail drawings, something to show the fit is essential to make a complete working drawing, and on more or less assembled drawings some marks of this nature are of no less importance, for each man having occasion to use the drawing



Indication of Finished Surfaces.

can tell at a glance what should be a running fit, what a driving fit, what ordinary machine finish, and what polished. The allowance for the fit is preferably made in the holes, the parts fitting them being machined to the exact figure given. This, however, is unimportant, as the allowance could be made on the parts fitting the holes, according to the individual shop practise.

The table below will give a clearer idea of the application and value of the marks. If each man is given a blue-print or card of the finish characters along with the first drawing on which they are used, no further trouble is found in making the men accustomed to their use.

TABLE OF FINISHING MARKS.

The following marks will be used on drawings to indicate the finish and fits required:

- f, machine finish.
- ff, machine finish, (polished).
- f^O, hand finish only.
- f^S, forcing fit, − 0.002 for first inch and 0.001 each additional inch.
- f^D, driving fit, − 0.001 for first inch and 0.0005 each additional inch.
- f^{DS}, easy driving fit; exact size.
- f^L, running fit, + 0.001 for first inch and 0.001 each additional inch.
- f^1, finish exactly to size.
- $G\ D$, gear distance.
- + or −, allowance between shoulders.
- ⟶ key drives this way.
- f^{AO}, finish all over.

All allowance for fit to be made in holes. Shafts to given dimensions. All dimensions in inches up to 8 feet.

* * *

The *Elektrotechnischer Anzeiger* gives the following method of sharpening files and other similar tools. The file is connected with the positive pole of a battery consisting of twelve Bunsen cells, and is then placed in a bath made up of 40 parts of sulphuric acid and 1,000 parts of water. The negative electrode is of copper wire wound in spiral form around the file, but not touching it. The action takes about ten minutes. It is said that files treated in this way appear to be quite new, and are satisfactory in use.

MAKING AN ACCURATE ARBOR.

HARRY A. S. HOWARTH.*

Herewith is described a job which a tool-maker sometimes meets with. It would be well if problems of this kind were better understood by the beginners and by those who do not give much thought to their work. Fig. 1 shows an arbor which it is essential to have as perfect as possible. The threaded hole *B C* should run perfectly true with the outside taper, and with the end *E*. The threaded hole is deep, and is to be sized with a tap so as to be of a standard dimension. In order that those of less experience may understand thoroughly the processes of making this arbor, the operations will be described briefly in detail.

Cut off a piece of stock to length, allowing for facing. Face both ends in a chuck to nearly the finished length; then center both ends carefully. Rough turn the arbor, and turn the end *E* true and smooth to a size slightly over its finished size. Place the steady-rest in position so as to guide the arbor at *S S*, as shown in Fig. 1, *A* being the spindle center. The dog

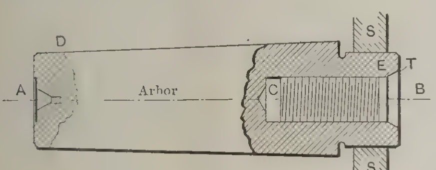


Fig. 1

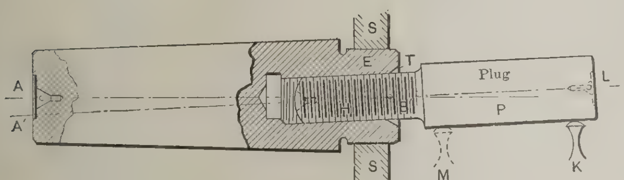


Fig. 2

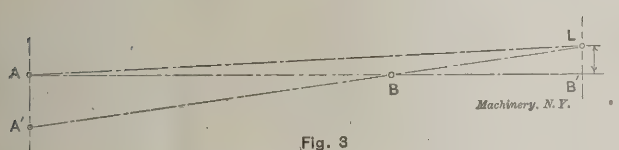


Fig. 3

Making an Accurate Arbor.

at *D* should be strapped to the face-plate so as to hold the arbor tightly to the center. Remove the tail-center, and, after securing the steady-rest, run the tail-center up to its place again and examine the center in the end *E* of the arbor to make sure that the steady-rest has not sprung the arbor out of line. If everything seems all right, push back the tail-stock, and proceed to drill and bore the hole *B C*. To get this perfectly true, it should be finished with very light cuts at a slow speed. The size of the hole should be slightly larger than the bottom diameter of the thread of the tap with which the hole is to be sized. It is difficult to fit a screw to a hole that has a full V thread. After boring the hole *B C*, recess its end *C* as shown, enlarging it to a little more than the full diameter of the thread to be cut. This makes a clearance space for the thread tool when cutting the thread. Then enlarge the end *E*, and bore the taper *T* carefully so that it can be used as a center later on.

The thread shown in Fig. 1 is a right-hand thread, and it should be cut carefully, making sure that the thread tool is set so as to cut a symmetrical thread. During the last few cuts the work should revolve slowly, and light cuts should be taken. Be sure the tool is hard and keen. After cutting the thread nearly to size, finish the hole with the taps, first using a blunt taper tap, next a plug, and last a bottoming tap. When but one tap is used it should be a plug tap with an amount of taper depending on the depth of full thread necessary in the hole. The usual chance for error in a job of this kind lies in the tapping of the hole. If not carefully done, the tap gets started out of true, and when finished, the thread in the hole is out of line with the center *A*. This error is shown exaggerated in Fig. 2. It is essential to test the arbor to discover the amount of error, if any, in its alignment. To do this, turn and thread on centers a plug that will fit the tapped hole firmly, without bottoming in the hole. The diameter of the threaded portion of this plug should be less than the diameter of the tap which was used to finish the thread in the arbor. Use another lathe in making this plug, so as to avoid disturbing the setting of the arbor. Screw this plug into the hole *H*, then revolve the arbor and plug slowly. The arbor is still in the steady-rest. Place an indicator against the end of the plug at *K*. The number of thousandths inch the end of the plug is out of true is shown on the indicator. The eccentricity of the center *L* of the plug is half the oscillation of the indicator pointer.

Referring to the diagram, Fig. 3, showing center lines only, the distance $L B'$ is the eccentricity of the plug at *L*. The line $A B B'$ is the center-line of the arbor, and $A' B L$ is the center-line of the tapped hole. It is evident that if the center *A* coincided with A' the arbor would be perfect. But we find in our case that the indicator shows an eccentricity of 0.002 inch when placed at *K*. This means that the oscillation of the pointer is 0.004 inch. Suppose that the center-lines intersect at a point *B*. This point can be determined approximately by proportion, after making one more test with the indicator. Move the indicator to point *M*, and the oscillation at this point will be more or less than at *K*. The point *B* is located where the oscillation would cease. In Fig. 3 it is shown near the end of the arbor, though it might be far outside. Produce the line $B L$ to A'; then A' would be the correct position for the center *A*. The distance $A A'$ is the eccentricity between the center *A* and its correct position A'. This distance may be determined by proportion.

$$A A' \div L B' = A B \div B B'$$

$$A A' = \frac{L B' \times A B}{B B'}$$

Suppose $A B = 6$ inches and $B B' = 2$ inches, and that, as we assumed before, $L B' = 0.002$ inch. Then

$$A A' = \frac{0.002 \times 6}{2} = 0.006 \text{ inch.}$$

Hence, if center *A* be drawn toward A' 0.006 inch, it will be in its proper place, *i. e.*, at A'.

After correcting our arbor, as suggested above, it should again be tested. This time, however, remove the steady-rest and run the tail-center up to the end of the plug at *L*. Rotate the arbor and plug on the centers A' and *L*, and test by placing the indicator at *M*. If we still find that the indicator shows an error, make the necessary correction by slightly scraping the center A'. When correct, no error should be shown by the indicator.

Now that we are assured that our centers are right, we can proceed to finish the arbor. If the plug is stiff enough, finish turn the arbor on the centers A' and *L*. If the plug is frail, simply use it to take a light cut on the end *E*. Then place the steady-rest on this new surface of *E*, and remove the plug. Bore carefully the taper shown at *T*. Remove the steady-rest and mount the arbor on its own centers A' and *B*, the latter being formed by the taper *T*. Then, finally, finish the arbor on the outside.

A slight variation from the above method is advisable when the threaded hole is large in proportion to the rest of the arbor. In this case the plug should be made in a chuck, and the arbor screwed onto it, and the center A' determined by spotting.

* * *

Our readers will remember that in our February issue we told something of the pathetic wanderings of an item of interest relating to the strength of grindstones, which was originally published in these columns, but which has since appeared in technical papers all over the globe, and been credited to almost every one under the sun except ourselves. It is with a feeling of sadness, and yet with an inner sense that perhaps it is for the best, that we report that this little item has at last reached a resting place in one of our contemporaries, in a column which is appropriately called the "Scrap Heap." Again we say "It is well."

*Address: The Hoggson & Pettis Mfg. Co., Box 123, New Haven, Conn.

REMARKS ON THE MAKING OF HAND TAPS.—2.

ERIK OBERG.

Change of Pitch in Hardening.

As is well-known, the pitch of a tap as well as its diameter will change in hardening, the pitch as a rule becoming shorter and the diameter larger. This tendency of change can be minimized by slow and even heating, combined with hardening at as low a heat as is possible for obtaining the desired results in the tap, but the tendency can never be fully overcome. For this reason it is necessary to cut the thread of taps on lathes having leadscrews slightly longer in the pitch than the standard. The tap will then also have a pitch slightly in excess of the standard before hardening, and if the excess length is properly selected, the tap will have a nearly correct

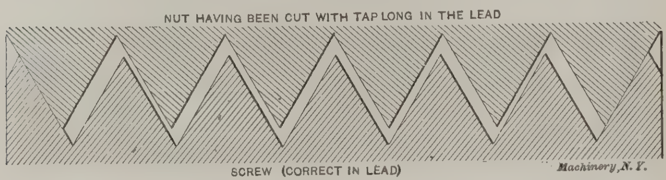


Fig. 1. Effect of Difference in Lead in Nut and Screw.

pitch after hardening. The amount that the pitch should be longer before hardening varies, of course, according to the makes and grades of steel. To give definite rules in this matter would be impossible, most particularly so, because the result of hardening may not always be shrinkage in the length of the piece to be hardened. Practical experiments have proved that in some cases, although rare, even when working with a most uniform grade of steel and handling it with the utmost care, there is no sure way of telling whether the result will be shrinkage or expansion. However, it has been found that most kinds of steel have an invariable tendency to contract lengthwise when hardened, and if this contraction has been found to be within certain limits in a few experiments, the steel may be fairly well depended upon to vary in the same way in so great a number of cases as to permit disconsidering those in which unexpected results are obtained. It is of interest to note, however, that exceptional cases have been observed where different parts of the same pieces have shown considerable difference in the amount of shrinkage.

While, as stated before, definite rules cannot be laid down, it may be given as a guide that most steels have an average shrinkage of from 0.016 to 0.020 inch per foot, when the ratio between the diameter and the length of the work does not exceed, say, 1 to 10. When, however, the threaded piece is very long compared with the diameter, as for instance in stay-bolt taps, the contraction is proportionally greater.

Special Lead Screw for Tap Threading.

The most common amount to cut hand taps long in the lead in one foot is about 0.018 inch. Stay-bolt taps and taps of a similar kind are often cut from 0.030 to 0.034 inch long in the lead in one foot. The lathes for threading taps should therefore be provided with special leadscrews. The ratio of the change gears for cutting these leadscrews is found from the formula

$$R = \frac{l \times r\,(12 + a)}{12n}$$

which was published in MACHINERY in April, 1905. In this formula

R = ratio of change gears to cut the thread a certain amount, a, longer in one foot than the same number of threads regularly pitched,

l = threads per inch on leadscrew of lathe,

r = ratio of gears in head of lathe,

a = amount thread is longer in one foot than the same number of threads would be regularly pitched, and

n = nominal number of threads per inch of work to be threaded.

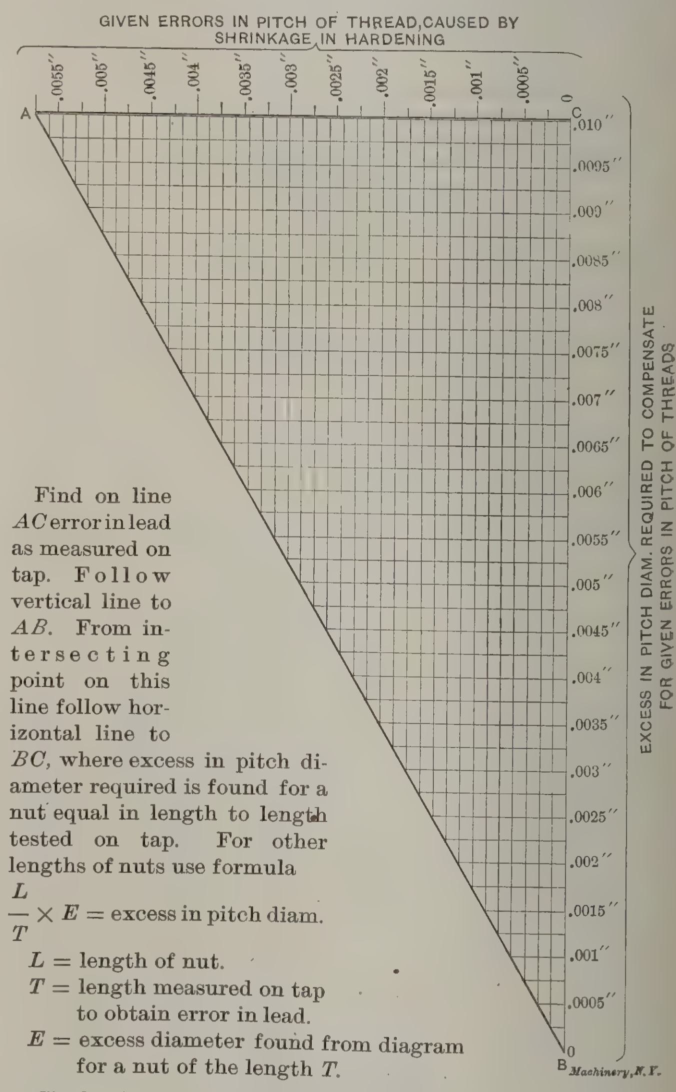
If we assume that we wish to cut a leadscrew which is 0.018 inch long in the lead in one foot, and that the nominal number of threads per inch in this leadscrew is to be 8, that the correct leadscrew in the lathe used for cutting the screw is 6 threads per inch, and finally, that the ratio of the gearing in the head-stock of the lathe used for cutting is 2, then our ratio of change gears, necessary to cut the leadscrew in question, would be

$$\frac{6 \times 2\,(12 + 0.018)}{12 \times 8} = 1.50225.$$

The gears used must be found by trial to correspond to this ratio. These trials are more or less lengthy, but no definite rule can be given except the one for finding the ratio according to the formula presented.

Provision for Difference in Lead of Tap and Screw.

While the method of using a leadscrew which is cut a certain amount long in the lead will prevent any serious deviations, the lead of the tap can, however, not be depended on to be exactly correct, even when the precautions referred to are taken, although it will be within very close limits. If the tap is long in the lead after hardening, the nut tapped will, of course, also be long in the lead, and will not fit a standard screw correctly. The resulting fit is shown exaggerated in Fig. 1. As this difficulty cannot be eliminated in any way, the only thing possible to do to arrange so that a screw of standard diameter and correct lead will go into a nut of incorrect lead, is to make the diameter of the nut, and consequently the tap for tapping the nut, a certain amount oversize, as is



Fig, 2. Diagram of Relation between Error in Lead and Excess Pitch Diameter of Taps.

shown in Fig. 1. This amount depends upon the length of the nut to be tapped, and upon the unavoidable error in the lead of the tap. As these quantities are difficult to settle upon, particularly when making taps for general purposes in great quantities, some standard figures must be assumed which would fill the requirements in all ordinary cases. In Table III. is given the amount of oversize near which the angle diameter of hand taps ought to measure after hardening. In

other words, the angle diameter must be between the standard angle diameter and the standard + the limits of oversize stated in the table, and should preferably be as near to the larger value as possible.

Swelling of Taps in Hardening.

Table III., of course, is only of value for inspecting taps after hardening, unless some data are given in regard to the amount a tap is likely to increase in diameter in the hardening process. If such data are given, it will make it possible to determine the angle diameter of the tap before hardening, this

TABLE III. LIMITS OF OVERSIZE IN DIAMETER OF HAND TAPS.

Size of Tap.	Limit of Oversize.	Size of Tap.	Limit of Oversize.	Size of Tap.	Limit of Oversize.	Size of Tap.	Limit of Oversize.
1/16	0.00075	5/8	0.002	1 1/2	0.00275	2 3/4	0.004
1/8	0.001	3/4	0.00225	1 3/4	0.003	3	0.004
1/4	0.00125	7/8	0.0025	2	0.003	3 1/2	0.0045
3/8	0.0015	1	0 0025	2 1/4	0.0035	4	0.0045
1/2	0.00175	1 1/4	0.00275	2 1/2	0.0035	..	......

TABLE IV. INCREASE IN DIAMETER OF TAPS, DUE TO HARDENING.

Diameter of Tap.	Increase Due to Hardening.	Diameter of Tap.	Increase Due to Hardening	Diameter of Tap.	Increase Due to Hardening.
1/16	......	1	0.002	2 1/2	0 003
1/8	0.00025	1 1/4	0.002	3	0.0035
1/4	0.0005	1 1/2	0.0025	3 1/2	0.0035
1/2	0.001	1 3/4	0.0025	4	0.004
3/4	0.0015	2	0.003	..	.....

figure being the only one which is of use when threading the tap. It is extremely difficult to state anything with certainty in this respect. Experiments with taps made from the same kind of steel, and under the same conditions, have proved that there may be very great variations in the swelling or increase of diameter due to hardening of taps, identically the same. In Table IV. are given such values as may be considered correct for average cases. These values refer particularly to the Midvale ordinary tool steel. As the amount of oversize necessary for a tap depends on the pitch rather than upon the diameter, the data given in Table IV. should be applied to taps with standard threads only.

The relationship between the pitch, the length of the nut, and the error in lead, on the one hand, and the excess in angle diameter on the other, is approximately expressed by the formula

$$D_2 - D_1 = \frac{ANL}{\tan 30 \text{ deg.}}$$

in which formula

D_1 = the theoretical angle diameter,

D_2 = the actual diameter wanted in the tap to compensate for the error in the lead,

A = the error in lead per each thread,

N = the number of threads per inch,

L = length of nut in inches.

Diagram of Relation between Error in Lead and Excess Diameter.

The relationship expressed by the formula above is shown in the diagram in Fig. 2. This diagram gives the excess in angle diameter required, over the standard angle diameter in taps, to compensate for given errors in the pitch of the thread due to shrinkage in hardening. If the error in the pitch in a certain length T is given, the diagram will give the excess in pitch diameter necessary to compensate for this error, assuming that the length of the nut to be tapped equals T. If the length of the nut to be tapped does not equal T, the amount of excess in pitch diameter required is obtained from the formula

$$\frac{L}{T} \times E = \text{excess in pitch diameter necessary to permit a correct screw to go into the tapped nut.}$$

In this formula L = length of nut to be tapped, and E = the excess in pitch diameter required for a piece to be tapped, the length of which is T, this excess being found by means of the diagram, Fig. 2.

In order to make perfectly clear the use of the diagram and the formula given, let us assume that the given error in the pitch of the thread in a length of 3 inches is 0.001 inch. Suppose the nut to be tapped is 1¼ inch long. Then $T = 3$; $L = 1\frac{1}{4}$; $E = 0.00175$ (found from the diagram in manner as will be immediately explained), and according to our formula

$$\frac{1\frac{1}{4}}{3} \times 0.00175 = 0.00075 \text{ inch (approximately)} = \text{excess in}$$

angle diameter required.

The value of E is found from the diagram by finding 0.001 on the horizontal line AC; then follow the vertical line from 0.001 to the line AB; from the intersecting point on this line follow the horizontal line to BC, and read off the nearest graduation on the scale on this line. The value obtained is E, or the excess in angle diameter required, provided the length of thread in which the error in lead is measured equals the length of the nut. Otherwise the amount of excess is found by the formula previously given, in manner as has already been explained.

It is common that the length of nut which is taken as basis for various taps, when they are to be used on general work, is assumed to equal the diameter of the tap. It is evident, however, that this will be correct only for taps with standard threads, because when threads finer than standard are used for a certain diameter, the length of the nut is usually shorter. The excess in angle diameter should therefore properly be determined rather by the pitch than by the diameter of the tap. This is done by several firms when inspecting taps made for them by outside concerns.

The Westinghouse Electric and Manufacturing Company makes use of a formula:

$$\text{Excess in angle diameter} = \sqrt{\text{pitch}} \times 0.01.$$

By means of this formula values a trifle larger than those given for limits of oversize in Table III. are obtained. In this formula the excess angle diameter is made directly dependent upon the pitch of the thread. In Table V. the values

TABLE V. LIMITS OF OVERSIZE IN DIAMETERS OF HAND TAPS.

No. of Threads per inch.	Corresponding Diameter, U. S. Standard.	Limit of Oversize = $\sqrt{\text{pitch}} \times 0.01$	No. of Threads per inch.	Corresponding Diameter, U. S. Standard.	Limit of Oversize = $\sqrt{\text{pitch}} \times 0.01$
3	3 3/4–4	0.0058	18	5/16	0.0024
4	2 3/8–2 3/4	0.0050	20	1/4	0.0022
5	1 3/4–1 7/8	0.0045	22	..	0.0021
6	1 3/8–1 1/2	0.0041	24	..	0.0020
7	1 1/8–1 1/4	0.0038	26	..	0.0020
8	1	0.0035	28	7/32	0.0019
9	7/8	0.0035	30	..	0.0018
10	3/4	0.0032	32	3/16	0.0018
11	5/8	0.0030	36	5/32	0.0017
12	9/16	0.0029	40	1/8	0.0016
13	1/2	0.0028	50	3/32	0.0014
14	7/16	0.0027	56	..	0 0013
16	3/8	0.0025	64	1/16	0.0012

of the excess for a number of pitches are given. The corresponding diameters of United States standard screws are also stated. This will permit comparison to be readily made with the values in Table III. It must be remembered that these values refer to the sizes of the taps after they are hardened.

Hardening Taps.

As mentioned before, the amount that a tap will alter its dimensions in hardening depends greatly upon the manner in which it is hardened; the heating must be made evenly throughout the tap, and it should be heated slowly; the water used for dipping should not be very cold; the tap, when dipped, should be held in a vertical position. The amounts given in the preceding tables are those resulting from hardening by experienced men in ordinary manufacturing of taps. But it must be clearly understood that the rules for hardening are all very indefinite; to say, heat slowly and uniformly, is very easy, but it is extremely difficult to actually do it, and experience only ever taught a man to harden a tap, or any other tool, right. Mr. E. R. Markham in MACHINERY, May, 1904, describes a method of hardening taps by means of which, he claims, the original pitch and diametrical measurements can be maintained. This method is termed "pack hardening," and is undoubtedly superior to the ordinary method.

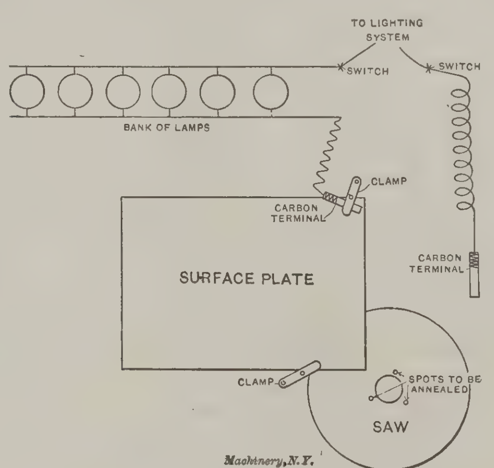
When hardening in the ordinary way, however, the tap is heated to the greatest advantage in a crucible of molten lead, heated to a red heat. There is some difficulty experienced, when heating taps in this manner, from the lead sticking to the tap. While there are a great many toolmakers who do not take any precautions to prevent this, it may be avoided by dipping the tap in a mixture of one part charred leather, one and one-half part fine flour, and two parts fine salt, all thoroughly mixed while dry, and converted into a fluid by slowly adding water until the mixture has the consistency of varnish. After dipping the tap in this mixture, it should be permitted to dry before being dipped in the hot lead.

In drawing the temper, it is evident that a certain temperature can hardly be settled upon, inasmuch as various kinds of steel do not require to be drawn to exactly the same degree. It may be said as a general rule that temperatures varying from 430 to 460 degrees F. will prove correct; the lower temperature mentioned is commonly employed for the oil baths used for drawing the temper in manufacturing plants. If any preference should be given to a definite temperature, it is best to make it a rule to draw large taps to 430 degrees F., and smaller ones, say up to 7/16 inch, to 460 degrees F.

* * *

SAW ANNEALING BY ELECTRIC ARC.

A contributor to the *Electrical World* describes how in a simple manner the electric arc may be utilized for annealing the center of a circular saw. For a certain milling operation it was necessary to use a 4-inch saw, 1/16 inch thick, so close to a projection on the work that it could not be supported on more than one side. A special arbor was made with a shoulder, and the saw was soldered in place. The heat of the solder,



Saw Annealing by Electric Arc.

however, made the saw buckle, and it broke loose after milling a few pieces. It was then decided to anneal the center of the saw, and fasten it to the end of the arbor with button-head screws. The device shown in the cut was used for the annealing. This device consisted of two pieces of arc light carbon connected up to the lighting system, which was 110-volt direct current, with six 16-candlepower lamps arranged so that one or more could be put in the circuit for resistance. The spots to be annealed were marked on the saw, and it was then clamped to one edge of a small surface plate. One of the carbon terminals was also clamped to the surface plate, and after turning on the current, the other carbon was held just far enough from the spot to be annealed to cause a good arc. This was continued until the spot was judged to be hot enough, and then the other spots were treated in the same manner. The result was so successful that the saw was easily drilled and countersunk at the annealed spots, and the screws put in flush with the side of the saw.

* * *

The report of the State Board of Railway Commissioners, in regard to the wreck of the electric train on the New York Central Railroad on February 16, in which twenty-four persons were killed, states that the direct cause of the wreck was a weak track. The Board, however, does not place the responsibility on any certain official, or on any group of officials.

GUARDS ON MACHINE TOOLS.

T. S. BENTLEY.*

There has been a growing recognition during recent years of the need for special precautions to lessen the risk of accidents due to machinery in motion. The danger to life and limb, from this cause, has greatly increased with the general adoption of mechanical appliances, in all departments of industry, in place of hand labor such as was formerly employed. While the community, as a whole, has benefited by the change in methods, it has been in too many cases at the cost of the individual, who has either found his occupation gone in consequence of the improved means of doing his work, or, having adapted himself to the new conditions, has found himself exposed to dangers from which he was formerly free.

While it is undoubtedly true that the majority of accidents from machinery ought not to occur—being principally due to carelessness or lack of skill on the part of the operator—there is still a large percentage that cannot be imputed to either negligence or want of skill, but must be admitted to be the result of pure misadventure. Now, whatever may be the precise cause of an accident, the result is pretty much the same; and it is practically impossible to discriminate between those in which the injured person is more or less culpable, and those in which he is purely the victim of misfortune.

In Great Britain—and indeed in most other countries also—the responsibility of the machinery owner is being more and more insisted upon, and, under existing employers' liability acts, he is liable in almost all cases to make compensation to the injured person. In many cases this amounts to a considerable sum, and the matter therefore is one which must be seriously faced. Of course this liability, like most others, is now a subject for insurance, and this is being largely resorted to. The premiums that are charged naturally vary with the probable risk, as far as it can be gaged, and the insurance societies keep a sharp lookout to see that all precautions are taken to reduce the dangers of accidents to a minimum. This means that the machinery owner has to satisfy not only the requirements of the government inspectors, but also those of the man representing the insurance company, which has a pecuniary interest in the safety of his plant. The result of all this is to make owners of machinery increasingly anxious that, as far as is possible, efficient protection shall be provided for all parts of the various machines which may be likely to inflict injury on anyone coming in contact with them.

The fitting of guards, as an afterthought, to machines whose designers have omitted them, is always a costly, and seldom a satisfactory, undertaking. The recognition of this fact makes buyers more and more insistent that suitable guards shall be provided by the makers of the machine, wherever necessary. So much is this the case that, other things being equal, a properly guarded tool will invariably be chosen in preference to one equally good in all other respects, but in which this matter has received less satisfactory treatment. Machine tool builders have largely responded to the demand thus produced, and all the most up-to-date firms are now furnishing their machines fitted with neat and effective guards, well-designed and altogether superior to the sheet iron makeshifts which have been generally employed for so long. There can be no question as to the fact that the makers of a machine are the right persons to design and fit proper guards for it. In the first place, it is often necessary either to modify the framework of the machine, so that part of it forms a portion of the guard, or to provide suitable lugs, etc., for the attachment of the guards when they are made in the form of additional fixtures.

While there is some difference of opinion as to how much guarding is really requisite, the general opinion is in favor of complete protection, not only of toothed gearing, but also of rapidly revolving wheels whose spokes might conceivably inflict injury. This latter is not considered indispensable by some inspectors, while others, on the contrary, insist upon it. As to gearing, this should be completely covered in. The little apologies for guards which some makers fit, merely across the entering teeth of a pair of wheels, are wholly

*Address: 113 Castleton Road, Ilford, Essex, England.

inadequate. Almost as much damage can be done between the moving teeth and the fixed guard as between the teeth themselves, if left bare. The back gears of lathes are now generally guarded, but the change gears should also be covered, and this is not always done. The same remark applies to the bevel gears which drive the spindle of an ordinary drill press; and in many cases the feed gears are insufficiently protected. In all cases of doubt it is well to do too much rather than too little, and in the long run this policy will be found to pay.

In designing guards, several different requirements must be kept in mind. They must be effective, and make injury practically impossible; otherwise they are worse than useless, in that they inspire a confidence that is delusive and misplaced. They must also be so arranged that they do not impair the convenience or efficiency of the machine they protect. If this is not so, they will be discarded in many cases by workmen, who, especially if on piece-work, will prefer to run a vague and incalculable risk, rather than put up with a certain and exasperating hindrance.

The guards must be so arranged that all necessary adjustments can be readily made, and oiling or examination of the parts can be easily effected. This sounds such an obvious requirement that it may seem needless to mention it, but in reality it is not always properly met. I have known cases where this matter has been so lost sight of that the guards, when in place, entirely prevented inspection, or even effective oiling, of some of the working parts; and, to aggravate the difficulty, they could not be removed till a great amount of gearing and mechanism had been stripped from the machine. Of course, these are extreme cases and doubtless due to the fact that the design of the guards has been considered an unimportant matter, and left to some junior draftsman who did not thoroughly understand the working of the machine, but they serve to show that a word or two on this aspect of the question is not out of place, or as unnecessary as it may seem to be.

There is one other consideration that is not without importance. This is the matter of appearance. A machine tool is, of course, built primarily for use, and if excellent service is obtained from it, many minor faults will be forgiven it by the man who is responsible for getting the work out. It often happens, however, that this man is so busy, and of such vital importance *in the shop*, that he cannot be spared to act as purchasing agent. Thus the man who actually places the orders is usually one of the managers of the firm, or else a "buyer." In either case he is not likely to be so intimately in touch with the practical details of workshop routine as to be guided by the same considerations as the superintendent would be. The "buyer" usually looks first at price, and is ever anxious to justify his title by securing bargains. The manager, being probably more closely connected with the commercial rather than the manufacturing end of the firm, is apt to base his judgment on general appearance instead of on such matters of detail as the shop man would look for. This makes it additionally important that the guarding should be well carried out, as the manager would have to meet any possible claims for compensation, and will not forget that fact. Besides, the appearance of a machine is rendered far more attractive by carefully designed and well fitted guards, and the natural inference is that makers who duly attend to these last finishing touches will have made very sure that everything else is as it should be.

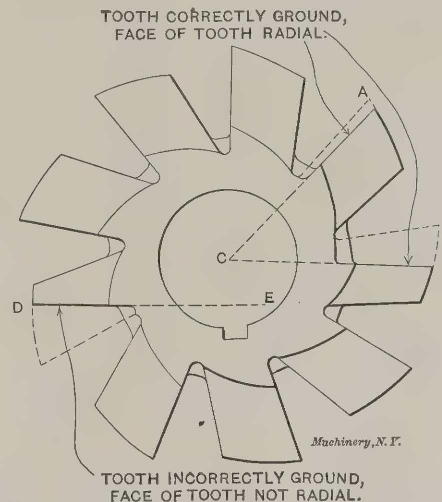
The conditions which we have reviewed are affecting all the markets of the world. They vary somewhat in degree, but cannot be ignored. No longer are guards mere trivial details, or fanciful additions; they are now essential parts of the machine, and as such can hardly receive too much attention from makers who are keenly alive to their own interests, and who intelligently read the signs of the times.

* * *

The statement that the tension per unit of cross-section area of a thin spherical shell subjected to internal pressure, is one-half as great as in a thin cylindrical shell of the same diameter and thickness, is true only when the strengthening effect of the heads of the cylinder is ignored.

IMPORTANCE OF GRINDING GEAR-CUTTER TEETH RADIALLY.

A leaflet, calling attention to the need of grinding gear-cutter teeth radially in order to secure satisfactory results, has been issued by the Union Twist Drill Co., Athol, Mass., and from it we have reproduced the accompanying illustration for the sake of impressing some elementary instruction in the art of grinding formed cutters. The cut shows, diagramatically, how the teeth should be ground to secure the best results; it also illustrates improper grinding. The teeth *A* and *B*, of course, are ground correctly. The lines *AC* and *BC*, lying in the plane of the cutting face, are radial; that is, the faces of the teeth would pass directly through the center of the cutter, if projected to the center. Tooth *D*, however, shows an entirely different condition, and one which we regret to say, is not uncommon in gear-cutting practise. The top of



Correct and Incorrect Grinding of Gear-cutter Teeth.

the tooth was ground back faster than the base, thus throwing the face of the cutter into the plane indicated by the line *DE;* consequently the shape of the tooth space cut is distorted, and a gear with badly-shaped teeth must necessarily be produced by it.

The expression, "may be ground without changing the form," has evidently been taken too literally and without the necessary qualification that it is necessary to grind in a plane radial with the center of the cutter in order that the form shall not be changed. It is evident to anyone who will give the matter a little thought that if a gear is cut with a gear cutter having teeth ground like *D* the resulting tooth space will be too wide at the top, if the cutter is carried to the correct depth. Moreover, such a gear-cutter works badly, as the cutting faces of the teeth have a negative rake. The importance of correct grinding of all formed cutters cannot be too strongly emphasized. Unfortunately, formed cutters that can be ground without changing the form, do not always have sufficient clearance to work well with all classes of work, and if such cutters are carelessly used there will be heating and rapid wearing away of the tops of the teeth. If hard pressed and ignorant, the tendency of the grinding operator, in order to hurry the sharpening of such cutters, is to incline the wheel away from the radial plane.

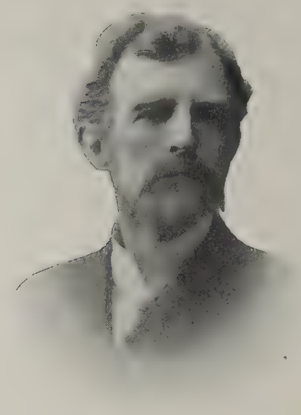
On account of this defect in formed cutters, one large concern making small tools has found it profitable in the use of certain formed cutters to make them the same as an ordinary milling cutter, with the same rake and clearance as is usual practise. When the cutters require sharpening, the teeth are ground on *top*, using a fixture which preserves the correct tooth shape. This concern has found the practise good, for the cutters are much more effective in action, and notwithstanding the increased cost of grinding, the increased efficiency more than makes up for the difference.

* * *

The 15th annual report of the General Electric Co. states that 350,000 horse-power of the Curtis turbo-generators were sold in 1906.

RECENT DEVELOPMENT OF BRITISH MACHINE TOOL INDUSTRY.

W. H. BOOTH.*



W. H. Booth.†

The status and prospects of the American machine tool trade in Great Britain is a subject that is frequently discussed on the other side, and is one that has been involved in quite a little obscurity, especially when clear ideas of the several factors involved have not prevailed. In order to understand the position and prospects, it will be well to start from the beginning and trace briefly the course of events as they have from time to time influenced the business, premising that there are two classes of American tool manufacturers, namely, those who are desirous of building up a permanent business on sound commercial lines, and those who have no particular desire to do more than take advantage of foreign markets for the purpose of unloading stocks when their home business is not brisk. There are, of course, others who blend the above two characters in varying proportions and with proportionately varying effects.

To begin from the commencement, therefore, it may be said that the American tool business in Great Britain was at one time practically limited to small tools and gages, and that machines cut no figure beyond, it may be, the high-class lathe for the use of the amateur mechanic, or perhaps an occasional drilling machine. Such, at least, is the experience of the writer, making the above statement in the entire absence of any actual statistics, and recalling the general impressions of the time referred to from his memory. As regards London, if not indeed the whole country, there were only one or two firms dealing with American tool products. Until, say, some ten years ago, the British machine tool industry had fallen gradually from its once high position into a trough of *laissez-faire* and inaptitude that rendered competition from the outside certain and inevitable, when the opportune moment should arrive, as in due time it did arrive.

Perhaps it would be unfair to blame British tool makers for the sleepy condition of non-improvement into which they allowed themselves to drift, or perhaps it should be said into which they were thrust. Secure in all markets, British products made by the aid of machine tools defied competition, and the cost of labor was ultimately gotten out of the purchaser. Under trade union rules, into a discussion of which one need not enter in this article, progress became by steady, stealthy steps virtually impossible. One man might not work two machines. He might not turn out from the one machine he did operate the half of what even the poor rating of the machine rendered possible. Of what use, therefore, was it for a machine tool maker to improve his machines by the addition of larger and wider belt pulleys, and the removal of the miserably inefficient cone pulley, which were barely competent to perform even the rating? The whole atmosphere of an average engineering workshop was irritating and depressing, the sound was of leisurely and persistent slowness, the shafting was run slowly, and the men grew slow and fat; and any really good man who could not put up with the restrictions of union rules drifted out of the trade, leaving behind only those to whom a slow, creeping life was possible. Thus the tone of everything was lowered, the demand for improved tools was reduced to a minimum, and the business of machine tool making fell into more or less disrepute.

Meantime the bicycle was being evolved, and the time was drawing near when the demand for it should become so great as to attract capital into the business. But no effort was seriously made by the British tool makers to anticipate the business, or to meet the demand when it arrived, so that, when the bicycle boom did fairly arrive, the field was open for the American tool maker, who was able to send over very large numbers of tools. The bicycle industry centered itself somewhat naturally at Coventry, where the decline of the watch trade had rendered available for the small work of the bicycle many mechanics who had been trained on the still finer work of watches. Bicycle making just suited their capacity, and the trade and prosperity of Coventry grew mightily, and still it required a revolution in the relations of employers and employed to stir up the British tool makers. This revolution followed upon the great strike of 1897. Brought about by the artificial restrictions upon output and interference by the unions with the ordinary every-day management of the workshops to such a degree as to render profitable work impossible in the face of foreign competition, there could only be two possible results of the strike or lockout. Either the British industry must have stopped, or work must have been allowed to proceed along business lines. The latter view prevailed, very much to the advantage of the employed as well as of the employer. Business at once revived, but again, as with the bicycle trade, found the British tool maker almost unable to cope with the situation. Just as a large trade had sprung up in the lighter classes of machine tools from America, so now there was a demand to be filled for heavy tools, which could hardly be met by home makers, who began to realize that the opportunity had come, which, if not taken at the flood, would have left the British machine tool trade forever in the ditch. Promptly was that opportunity grasped. It was grasped by nearly all the British makers in the usual British fashion, for it was only taken in hand when they were hopelessly beaten and discredited, when they were in the last ditch of despair. They made a great effort and began to recover trade. They were perhaps helped by the revival of business in America, which tended to restrict the too plentiful supply of American tools, but there was another factor pressing forward, again an American factor. I refer to the discovery of the Taylor-White tool steel. This steel was the logical outcome of the discovery by Mushet of the peculiar steel known by his name. The Taylor-White steel was a further step in the same direction. Its discovery practically coincided with the awakening of the British machine tool makers, the revival of trade and the increased demand for tools, with the revolution in shop practise and the removal of the worst of the restrictions upon production, and with the reduced supply of the surplus tool manufacture of America.

British tools have often been decried on account of their clumsiness. They have been alleged to possess far too much weight for the work they had to do. Probably there was some truth in this for the light cuts that had been in vogue. But the tendency to clumsiness remained. It seemed easier to design such heavy machines. And suddenly comes along a steel, to make proper use of which it was necessary wholly to redesign all tools intended to be operated with the new steel. The Sheffield steel makers entered into the question of high-speed steel with great energy. Every maker of tool steel had his brand. The use of the new steel by a few, compelled others to follow suit. Forgings could be made less close to size, so cheap was it to remove excess material. The whole practise of the shops soon became revolutionized, and the

* Address: 25 Queen Anne's Gate, Westminster, S.W., London, England, and care Hill Publishing Co., 505 Pearl St., New York.

†W. H. Booth was born in Rochdale, in the county of Lancaster, England. He was educated in Queen Elizabeth's or Archbishop Parker's grammar school of that town and at Owen's College in Manchester, now known as Victoria University. His engineering experience was gained in the works of John Petrie & Co., builders of steam engines, water mills, pumps, boilers and general line of engineers' machinery, and in the mechanical department of the cotton factories of his father and uncle. His training was along the old-fashioned lines of the days of Rennie, Maudslay, Fairbairn, Boulton and Watt, and covers a very wide range of engineering practice, including almost every branch of modern development. His steam engineering experience was begun when steam pressures of 30 pounds per square inch were being used in engines that had been built to use only 7 pounds pressure. The safety-valve of his father's first boilers was merely a 15-foot vertical open pipe carried up the side of the factory wall and filled with water, which slopped over when the pressure got too high. He has had a wide range of engineering experience in England, New Zealand, and Australia. He is perhaps known best in America for his work in the prevention of smoke and improved coal consumption, having written and lectured extensively on this important subject. At present he is official lecturer to the London Coal Smoke Abatement Society. He is a designer of furnaces specially adapted for burning long-flaming bituminous coal so as to develop the calorific value of the fuel fully before the gases are exposed to the comparatively low temperatures of the water surface of the boiler. Notwithstanding the great progress made in engineering practice generally, Mr. Booth finds that the apathy of most engineers in regard to fuel burning is appalling. He finds practices in vogue that were condemned by his father years ago as being wasteful and unproductive of good results. He has been actively interested in the use of blast furnace gas, having been associated with Mr. Thwaite in this work. Mr. Booth is the author of books on liquid fuel, steam pipes, condensing plants, smoke, etc.

tool builders, who had to make new patterns anyhow, made them heavy, which suited the general views of tool making that had always prevailed, and which, from being a debatable fault, became a necessary virtue. Meantime the business boom in America increased and competition from abroad became less keen. The net result has been to establish the British tool maker on a firm basis, manufacturing tools that must be heavy before they are elaborate. Indeed, the new high-speed steels have eliminated much of the elaboration of the machine tool, and completely changed the general aspect of the business. When therefore we read, as we may sometimes do, that the import of American tools into Great Britain has declined from its high position of a few years back, we have to remember that the conditions were abnormal, that there was a time when any old second-hand tool would sell, perhaps, better than a new tool, and that the British industry was asleep.

There is, however, no reason to suppose that a steady business of exporting tools to Great Britain will not be maintained. Much depends on the attitude of the American tool maker himself. If he merely aims at selling surplus output, he will hardly expect to build up a steady export trade, for European buyers are shy of making purchases from sources which they suspect may suddenly become dry. This is, of course, only natural, for a man does not care to fill his shop with samples of all the makers of drill presses or planers. He wants a similar class of tool for all similar work. Just how far it may pay an American tool maker to foster his foreign trade must be entirely a matter for his own judgment. Many of them, no doubt, in bad times have felt glad to be able to ship surplus product to Europe at good prices, and while doing so have probably come to the commendable resolve to nurse foreign business. Then comes along a revival at their doors; the tool ready for shipment abroad is sold to a pressing home customer. The bird in hand is found to be more enticing than that still in the branches, and the foreign customer is put off, much to his distress, especially should he happen to have actually seen the machine intended for him in the last stage of work, for he then realizes that his interests have been sacrificed to those of another. But there seems no reason whatever why a steady business should not be done by the man who deals alike with all his customers. The probability is that by spreading his products over a wider field, he will find that his capacity of production is more evenly balanced with the average demand, for the coincidence of a maximum demand in a number of different countries is not probable. Rather will a peak in the demand in one coincide with a period of small demand in others, thus conducing to a more even general average.

Such, then, is a rough outline of the history and development of the British machine tool industry during a period of ten to fifteen years, which includes the great boom in the cycle trade, the revolution of British shop practise, and the invention of the high-speed tool steel which has removed to a further distance than ever the last syllable of the word "finality" as applied to the machine tool. The mere fact that high-speed steel will live and cut when red hot has entirely subverted all established ideas which were based on a conviction born of experience that a red heat in metals was incompatible with anything except a passive state. Once this deeply rooted idea has been destroyed, men's minds are prepared for further developments, and he would be a bold man who should attempt to lay any limit to physical and mechanical progress. The machine tool maker may therefore always live in expectation of some fresh turn of fortune's wheel which will bring a winning number opposite his shop door, whether it be on the east or west side of the Atlantic.

* * *

A trick worth knowing in case a crank-pin works loose or a press fit is made slightly too small is to heat the pin to a "black" heat and dip it into a pot of yellow brass, using boracic acid as a flux. Wipe off the superfluous metal as the pin is removed from the pot. In this manner a considerable thickness of brass can be evenly deposited on a pin, giving sufficient material for re-fitting the pin. In short, this is a "putting-on" process.

DEFLOCCULATED GRAPHITE AND THE "ACHESON EFFECT."*

Mr. Acheson, the discoverer of carborundum, has added another item to his list of important discoveries. This new amorphous substance, "deflocculated graphite" as he calls it, is described in the following abstract from an article in a contemporary:

In 1901 Mr. Acheson engaged in a series of experiments, having as their object the production of crucibles from artificial graphite. This led him to a study of clays, and he learned that American manufacturers of graphite crucibles import from Germany the clay used by them as a binder of the graphite entering into the crucibles; also that the German clays are more plastic and have a greater tensile strength than American clays of very similar chemical constitution; while residual clays—those found at or near the point at which the parent feldspathic rock was decomposed—are not in any sense as plastic or as strong as the same clays are when found as sedimentary clays at a distance from their place of origin. Chemical analysis failed to account for these decided differences.

Under these conditions, Mr. Acheson reasoned that the greater plasticity and tensile strength were developed during the period of transportation from the place of their formation to their final bed, thinking possibly it might be due to the presence of vegetable extractives in the waters which carried them. He made several experiments on clay with vegetable extracts, tannin being one of them, and found that a moderately plastic, weak clay, when treated with a dilute solution of gallotannic acid, or extract of straw, was increased in plasticity. Familiar with the record of how the Egyptians made the Children of Israel use straw in the making of bricks, and believing it was used not for any benefits derivable from the weak fibers, but for the extract, he calls clay so treated Egyptianized clay.

In 1906 Mr. Acheson discovered a process of producing a fine, pure, unctuous graphite. He undertook to work out the details of its application as a lubricant. In the dry form, or mixed with grease or oil, it was easy to handle, but he wished it to enter the entire field of lubrication, as occupied by oil. In his efforts to suspend it in oil, he met the same troubles encountered by his predecessors in this line of work. It would quickly settle out of the oil. His unctuous graphite was just plain, simple graphite, and obeyed the same laws covering the natural product.

In the latter part of 1906 the thought occurred that tannin might have the same effect on graphite that it did on clay. He tried it with surprising results. The "effect," for such it must be termed, is produced with water and a comparatively small quantity of gallotannic acid, and when thus treated the unctuous graphite remains suspended in the water, showing not the slightest disposition to settle. The black liquid passes with ease through the finest filter paper. Severe tests have demonstrated that it is an admirable lubricant. There is every reason to believe that deflocculated graphite, with or without oil, will become a popular agent for all classes of lubrication, for, strange as it may seem, deflocculated graphite possesses the remarkable power of preventing rust or corrosion of iron or steel. The graphite appears to entirely neutralize the effect of the water in which it is suspended.

Mr. Acheson was desirous of mixing this graphite with oil, in order to meet the demands for a mixture of this kind. This was a matter of greater difficulty than was at first expected, but it has been finally accomplished, so that oil and graphite will run through fine filter paper, as described for a mixture with water. In these circumstances, Mr. Acheson now feels assured that he can meet any demand for a lubricant where oil is preferable, and evaporation of his water lubricant might be objectionable. It should be understood in this connection that the very lightest and thinnest of oils, when used in conjunction with deflocculated graphite, can be used in the place of the heavy and expensive lubricating oils of the present day, while the lasting qualities of these graphite lubricants will be greater by far than the oil lubricants which it is hoped they may displace.

*Orrin E. Dunlap, in *Scientific American*, May 11, 1907.

ADJUSTABLE REAMERS AND TAPS WITH INSERTED BLADES.

In the November, 1906, issue of MACHINERY a few designs of interchangeable body and guide counterbores were presented, and the reasons for making tools with the cutting members inserted were mentioned. The accompanying cut, Fig. 1, shows the construction of a reamer with inserted blades; the body and shank are made out of ordinary machine steel, while the blades and the binders are made of tool steel. There has been a number of various designs of inserted blade reamers on the market, but there are few which fill the requirements in all respects as well as the one presented here.

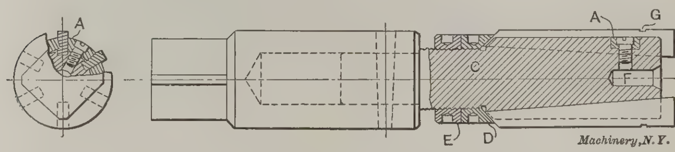


Fig. 1. Adjustable Hand Reamer with Inserted Blades.

As seen from Fig. 1, the reamer consists of a body *C*, which has one end turned down to fit into a hole in the shank, six blades, and six binders *A*, and finally a binding nut *D* and a check nut *E*, which are mounted on the threaded part of the body. The end of the body which is turned down to fit the hole in the shank is driven in place, and is secured by means of a taper pin. The body is slotted longitudinally to receive the blades, and has a circular groove all around to receive the binders. The latter are held firmly to the shoulder *B* on the blades (See Fig. 2) by means of screws which are threaded into the body. The hole *F* shown, extending in the center of the reamer a trifle beyond the center-lines of the binding screws, is for the purpose of providing clearance for the tap when tapping the screw holes. The blade is beveled off at an angle of 45 degrees at its upper end, and the binding nut is chamfered on the inside to correspond. This arrangement provides for a strong grip of the nut on the blades. The binders are made from a solid ring, being turned, chucked, reamed, and the screw holes drilled and counterbored, before the ring is cut into pieces. The blades are ground cylindrical for a certain distance towards the point of the reamer. This cylindrical part serves as a guide in starting the reamer. The remaining part of the blade, from the neck *G* upwards, is ground and relieved as an ordinary hand reamer.

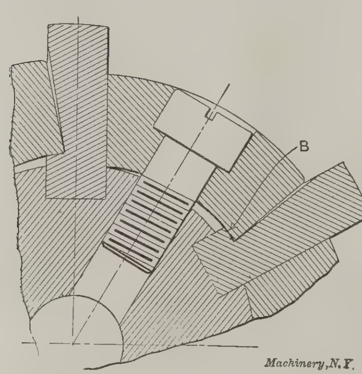


Fig. 2. Enlarged Section of Reamer, showing Method of Binding.

In Fig. 3 a shell reamer is shown of the same design. The hole is intended to receive a regular shell reamer arbor, and the reamer is driven by means of the keyway *H*. The blades of this reamer are shorter, are provided with a radius at the point like regular shell reamers, and are relieved all way up and slightly back tapered. This back taper is equal to 0.012 inch per foot. The radius *R* at the end of the blade should be about 1-16 inch for sizes up to 4 inches diameter and ⅛ inch for larger sizes.

The requirements for a good inserted blade reamer are that the blades, when bound in place, shall be practically solid with the body, that the design shall permit a liberal adjustment in regard to size, that this adjustment shall be easily accomplished, and that the means employed for binding and adjusting the blades shall not be of such a kind as to prevent the use of the reamer in any case where a solid reamer could have been used. The design shown in the cuts fills all these requirements. When the binders *A* are tightened down against the shoulder *B* in the blade, and the nuts are screwed tightly up against the end of the blade, there is very little chance for the blade to move. The tapered bottom of the slots in the body of the reamer, into which the blades are fitted, provide for the adjustment. When the reamer is worn, the binders are loosened, and the nuts at the upper end of the blades screwed back. The blades can then be moved upward as far as is necessary for recovering the original size, the nuts and the binders are again tightened, and the reamer may be ground to the exact diameter required. The ease of accomplishing this adjustment is apparent. No details either used for binding or adjustment project outside of the reamer, neither at the end nor at any place on the diameter of the body. The reamer can not only pass entirely through a hole, but it can ream down to the bottom of a hole, and even, to a certain width, face the bottom if necessary. Very few reamers of the ordinary adjustable or expansion type fill all the requirements so well.

This must not be construed to mean that this is the only adjustable reamer possible which will fill the requirements outlined. There can, of course, be a great deal of variation in the design, but the one in question, although patented in one important detail, is chosen as an example, because of embodying all the features which are of importance.

Inserted blade taps can also be made on the same principles. In a tap, however, it is not necessary, as in the case of a hand reamer, to have the shank nearly up to the full

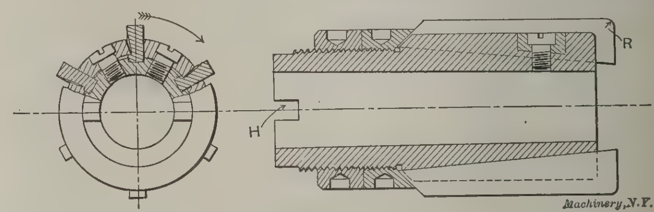


Fig. 3. Adjustable Shell Reamer.

diameter of the cutting tool itself. In the case of a tap, instead, it is required that the diameter of the shank shall be below the diameter at the root of the thread so as to permit the shank to freely enter the threaded hole. The tap can for this reason be made with the shank solid with the body. The only requirement for this is that the diameter of the shank must be below not only the root of the thread of the tap, but also the root of the thread of the threaded portion *K* (see Fig. 4). In small taps, however, this is not possible, as there the diameter of the shank would be altogether too small in comparison with the diameter of the tap. In such cases the same arrangement as resorted to in hand reamers must be adopted. Fig. 4 shows two taps, one with the body and the shank in a solid piece, and one with the body inserted in, and pinned to, the shank.

Another difference in the design which will be noticed is that the end of the blade, instead of being beveled, is made square with the outside face of the thread. This arrangement is necessary in order to insure that the different blades in the tap will have their teeth in such rotation that when the tap is used, a perfect thread will result. The adjusting nut is therefore made with a plain face instead of being beveled off

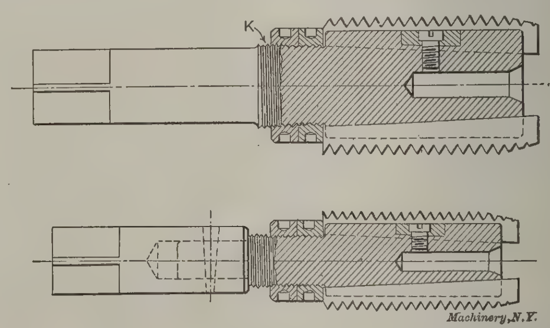


Fig. 4. Adjustable Taps made on same Principles as Reamers.

as in the case of reamers. It is evident that it is difficult to replace single blades, as they would hardly come in such a position as to produce a correct lead. For this reason it is customary to replace all the blades at once, preferably threading them right in the holder, or in a master holder similar to the tap. As there is no bevel on the adjusting nut to hold the blade down at the upper end, it is necessary to move the binding shoe in the case of the tap nearer toward the center of the blade.

NICKEL-CHROME STEEL.*

E. F. LAKE.†

E. F. LAKE.‡

Of the many high grades of steel which have been brought out in the past few years, nickel-chrome steel has, by both laboratory and practical tests, been placed in the front rank as the highest grade of steel manufactured, and it is used on all classes of high-grade machinery that require a steel of high tensile strength, high elastic limit, and a great resistance to shock and torsional stresses. It is one of the latest products of the steel maker. Only eight years ago this alloy of steel was comparatively very little known, and it was a boast of the Germans "that the entire steel trust of the United States could not duplicate a

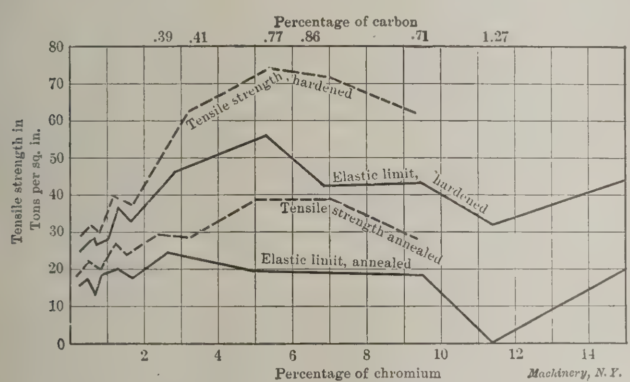


Fig. 1. Diagram showing Effect of Chromium on Steel.

Mercedes front axle." In the last two or three years that boast, however, has ceased to be true. To-day this alloy is being produced by a number of American steel makers at a price much below the twenty-six cents a pound that the Krupp works gets for its highest grade of steel, in New York, duty paid.

Nickel-chrome steel is made in many different compositions, some of which are high in tensile strength, some in elastic limit, and others having different qualities, demanded for the different uses to which they are to be put.

The Effect of Chromium.

Chromium added to steel up to 5 per cent increases the tensile strength and resistance to shocks, and diminishes the elongation, while further additions lower the tensile strength. The elastic limit, in pieces not annealed, is raised at first, and afterward lowered. Chromium resembles carbon in its influence on the hardening qualities of steel. It refines the grain remarkably, owing to its tendency to prevent the development of the crystalline structure. Added to nickel steel, it overcomes the tendency of lamination, increases the elastic limit to figures that were impossible before it was brought into use, and when given proper heat treatment, the steel practically shows no grain or fiber, thus possessing a high power of resistance to shock. This alloy also strongly resists the propagation of cracks which may be produced by sudden strains. Chromium intensifies the sensitiveness of the steel to the quenching process, the resistance to fracture is higher than in carbon steel of the same degree of hardness, and for this reason extreme hardness may be obtained. Two per cent or more of chromium added to steel makes it very difficult to cut cold, although a special tool steel is made which overcomes this to a large degree. Chromium's action on steel becomes decisive above a content of one per cent.

The effect of chromium on steel is best illustrated by the diagram, Fig. 1, taken from Austen's "Introduction to Metallurgy." The lower dotted line shows the tensile strength of annealed pieces, the lower full line shows the elastic limit of annealed pieces, the upper dotted line shows the tensile strength of the steel, when hardened, and the upper full line shows the elastic limit of the steel, when hardened.

The Effect of Nickel.

The presence of this metal in steel is very interesting in its influence, as, when added to steel up to 8 per cent, it increases the tensile strength, elastic limit, and elongation. Adding from 8 to 15 per cent of nickel produces a brittleness, and the mechanical properties are not ascertainable by experiment. With 20 per cent nickel a rapid rise in extensibility is noticed, which increases very rapidly up to 25 per cent, after which the increase is more slow. Fig. 2 is a diagram from Roberts-Austen's "Metallurgy," which illustrates these points better than words will.

Nickel increases the ability of steel to withstand shock stresses even though the shape be intricate and lightened with holes. When properly combined with carbon, it largely removes the tendency of crystallization, and the steel may be hardened by the cementation process without fear of the core being brittle. If high in carbon, however, it will not stand local hardening, but may be oil tempered without difficulty. Nickel also gives steel a tendency to show laminations and makes it weak at right angles to the direction in which it is rolled. By the addition of chromium these laminations are removed, and the metal is given a high degree of homogeneity, the hardening can be performed more easily and without the danger of fissures appearing.

In nickel steel, the tenacity and elastic limit is much increased by positive quenching up to about 5 per cent nickel, especially with high percentages of carbon. Below 0.50 per cent carbon and 5 per cent nickel the reduction of area remains nearly unchanged, and the elongation but slightly decreases by heat treatment, but when chromium is added these are both reduced nearly one half by heat treatment.

Effect of Silicon.

Silicon is sometimes used in nickel-chrome steel, as it prevents the formation of blow holes and neutralizes the injurious tendencies of manganese. The majority of these steels, however, do not contain silicon, as its exact influence is not quite clear, and it is difficult to obtain silicon in steel without the presence of manganese. This makes its direct action difficult to determine. In quenching, silicon seems to influence steel the same as carbon in many ways, but this largely depends on the co-existing amount of the latter as well as of manganese. In general, only very small quantities are effective, and then only when the carbon content is low. Silicon will increase the tensile strength, but at the same time lower the elastic limit.

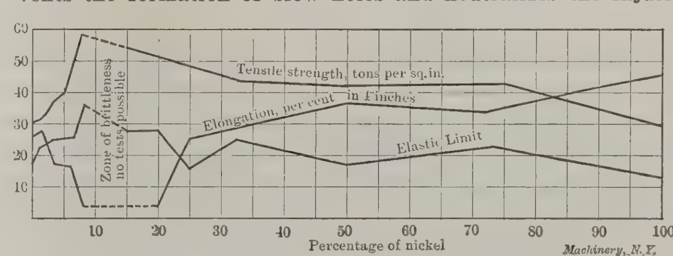


Fig. 2. Diagram showing the Effect of Nickel on Steel.

Effect of Manganese.

Manganese is always a component of nickel-chrome steel, but over 0.40 per cent is seldom allowed, as a steel high in manganese is difficult to work cold, while otherwise nickel-chrome steel can be bent cold without difficulty. This has been proved by tests which have been applied, one of which was a connecting or piston rod that, after finishing, was bent double and showed no indications of cracks. Another rod was twist-

*For additional information regarding the manufacture and characteristics of this and kindred steels, see the following notes and articles, previously published in MACHINERY: Remarkable Properties of Nickel Steel, February, 1903; Properties of Nickel Steel, March, 1903; The Effect of Vanadium on Steel, February, 1904; Krupp's Improved Spring Steel, February, 1904; Alloy Steels, August, 1904; all in engineering edition.

† Address: 701 E. River St., Elyria, Ohio.

‡E. F. Lake was born in Oswego, N. Y., 1863. He served an apprenticeship with the Straight Line Engine Co., Syracuse, N. Y., and has since been employed by The General Electric Co., Schenectady, N. Y.; Mesta Machine Co., West Homestead, Pa.; Lorain Steel Co., Lorain, Ohio, and The Garford Co., automobile manufacturers, Elyria, Ohio. Mr. Lake has a wide experience, having worked as machinist, molder, and pattern-maker, and has passed from the ranks to the positions of assistant foreman and foreman. For the past ten years he has made a special study of metallurgy and internal combustion engines, and has made many tests and experiments along these lines. He has contributed considerably to the technical press.

ed two complete revolutions without injury. When the carbon is less than 0.50 per cent, and from 4 to 6 per cent of manganese is added, steel becomes so brittle that it can be powdered under a hand hammer, but by the addition of twice that amount of manganese the strength is restored. At 15 per cent manganese, again, a decrease in toughness, but not in transverse strength, takes place. With 20 per cent and more of manganese a rapid decrease takes place. The discovery of these properties brought out manganese steel which has some remarkable qualities. The higher the percentage of carbon, the less manganese is necessary to bring about the result referred to.

Influence of Phosphorus and Sulphur.

Phosphorus and sulphur are always components of steel, and probably more time, more energy, and more money has been spent to get rid of these, or reduce them to a minimum, than on all other experiments. Phosphorus causes a "cold shortness" or brittleness in steel, and almost any quantity is injurious. No matter how high the tensile strength or elastic limit may be made by other components, if phosphorus is high, the metal will break when given shock tests. For this reason some object if phosphorus is present in amounts over 0.015 per cent, while others will allow as much as 0.04 per cent before they will agree that it is damaging to any serious extent. A high percentage of sulphur, on the other hand, causes a "hot shortness" or brittleness beyond a dull red heat, and is therefore not desirable when the metal is to be forged or worked hot. This component, however, is not as injurious as phosphorus.

used principally for gears, as these are the highest grades of steel in the market, either foreign or domestic, for this purpose. The nickel-chrome steels shown in the table that contain 0.25 per cent carbon are more extensively used than those with higher carbon content, as they are forged easier, and are machined and worked with less difficulty. These steels are used where great strength is demanded, combined with a light weight; hence, in automobile construction they are used for such parts as crank shafts, sprocket shafts, rear driving shafts, propeller shafts, axles, wheel pivots, and piston rods. Some racing cars have been built with all the working parts, as well as the frame, of nickel-chrome steel.

These nickel-chrome steels are not as readily drop-forged as the ordinary carbon steel, and therefore the difference between consecutive die forms should be less than in those used for ordinary steel. In forging, the metal should be heated to about 1,380 degrees F., and kept at about that point until the operation is completed. Care must also be taken not to overheat or underwork the metal, as this produces a coarse grain, which will show a low percentage of reduction of area, and the metal will be condemned on account of its inability to withstand the shock stresses. The best forging process is undoubtedly the one using the hydraulic press, as with this the metal is slowly squeezed into the die, thus allowing the mass time to assume its new shape. The formation of crystals will not be able to take place, and the metal will be of a finer grain, with greater density, producing less internal stresses and closing up any flaws which might have been in the center of the ingot. In hammer forging,

TABLE SHOWING DIFFERENT COMPOSITIONS OF NICKEL-CHROME STEEL AND THEIR STRENGTHS.

Nickel, per cent	1.60	3.30	4.40	3.50	2.09	3.38	1.50	1.50
Chromium, per cent	4.41	1.40	1.50	1.50	0.71	1.87	0.80	0.80
Carbon, per cent	0.25	0.31	0.25	0.25	0.36	0.24	0.25	0.45
Silicon, per cent	0.20	0.20	0.24	0.25	0.21	....	....	....
Manganese, per cent	0.35	0.40	0.73	0.40	0.35	0.35	0.40	0.40
Phosphorus, per cent	0.012	0.012	0.013	0.018	0.025	0.028	0.03	0.03
Sulphur, per cent	0.013	0.028	0.012	0.022	0.026	0.03	0.035	0.035
Fully Annealed.								
Tensile Strength, pounds per square inch	126,000	115,000	....	126,000	112,000	123,000	85,000	90,000
Elastic Limit, pounds per square inch	115,000	95,000	....	115,000	87,000	80,000	65,000	65,000
Elongation in 2 inches, per cent	28	24	....	28	14	10	20	18
Reduction of Area, per cent	64	42	....	64	64	53	50	35
After Heat Treatment.								
Tensile Strength, pounds per square inch	185,000	155,000	154,000	....	....	....	130,000	180,000
Elastic Limit, pounds per square inch	160,000	132,000	133,000	....	....	....	100,000	140,000
Elongation in 2 inches, per cent	14	38	12	......	....	....	12	8
Reduction of Area, per cent	48	16	25	....	....	....	30	20

Composition of Nickel-chrome Steels.

The different combinations or percentages of the components of nickel-chrome steels are as varied as their makers, but the compositions obtained have resulted in a very high grade of steel. Thus nickel is used in percentages of from 1 to 5, chromium from ½ to 5, carbon from 0.25 to 0.45, silicon, when used, from ½ to 3, and manganese from ¼ to 1. The table above shows some of the nickel-chrome steels that are turned out by the different makers, both foreign and American, and their comparative strength. The first column shows one composition that is comparatively low in nickel and high in chromium, while the next three columns are low in chromium and high in nickel, other components being about equal. The last two columns contain the specifications adopted by the Association of Licensed Automobile Manufacturers. The only difference between them is that one contains 0.45 per cent carbon and the other is 0.25 per cent. The physical characteristics of these two kinds are not derived from actual tests, but are the characteristics which they must possess when a test is made from a ⅞-inch test bar, rolled from every heat and from two separate ingots. The actual test may show much higher figures, as these are the lowest figures at which the steel will be accepted. The phosphorus and sulphur may, of course, be lower, as the percentage given is the highest that will be allowed. To the tests in this table there should be added a shock test, as all of these might be satisfactory in their results, and yet, if too high in phosphorus, the metal would not stand shock and torsional stresses.

The steels given in the table which are high in carbon are

unless the hammer is a large, slow-moving one, only the shell of the forged piece is affected, as the blows will not penetrate to the center.

Heat Treatment.

This steel is nearly always heat treated, and great care should be used in doing this, as it is very easy to destroy the good qualities of the metal by inferior workmanship in this regard. The factors which influence the results of heat treatment are:

First: The physical and chemical components of the metal.
Second: The gases and other substances which come in contact with the metal while heating.
Third: The form of the temperature rise curve for each unit of the metal.
Fourth: The highest temperature given to each unit of the metal.
Fifth: The length of time at which the metal is kept at the maximum temperature.
Sixth: The form of the temperature drop curve for each unit of metal.

At about 570 degrees F. most steels lose their ductility and are not capable of resisting the strains of unevenly heated metal. Therefore, the temperature rise curve up to this point should be a gradual one; after this it may be as rapid as possible without overheating. Care must be taken not to overheat or burn the metal, as it is almost impossible to bring it back to its former high standard.

Nickel-chrome steel should be annealed after it has been worked and before heat treatment, in order that it may return to its natural state of repose, as machining, forging, hammering, etc., is liable to throw it out of its homogeneity. It is

annealed in a different manner from the ordinary grades of steel, it being heated to a temperature of about 1,470 degrees F., kept at this heat for four hours and then allowed to cool slowly in a slow-cooling furnace, or by packing in ashes or charcoal, the latter being preferred. If carbonizing is resorted to, this steel should be annealed, after carbonizing, as described above.

To harden this steel, it should be heated to about 1,470 degrees F. and made as hard as possible by quenching in oil or water, after which it can be drawn to the different degrees required. Gears should be drawn by heating to 480 degrees F. to remove the internal strains. This makes the hardest and toughest gear which it is possible to make. It will stand an enormous amount of wear and shock stresses, and it is very difficult to break out a tooth with a sledge hammer.

The carbonizing should be done by carefully packing the pieces to be carbonized in a cast iron pot, in a mixture of powdered bone and charcoal. This should then be heated slowly until the temperature is raised to 660 degrees F., after which the temperature can be raised as fast as desired until 2,100 degrees F. has been reached. The steel should be kept at this temperature for at least four hours, after which it should be allowed to cool slowly by taking the pot out of the fire and permitting it to cool without removing the cover. This annealing, tempering, and carbonizing can only be done successfully and with positive assurance by the use of a furnace to which is attached a pyrometer, as the proper degrees of heat cannot be guessed at by the color of the metal.

Machining Nickel-chrome Steel.

Nickel-chrome steel is more difficult to machine than ordinary steel. This can only be done successfully when fully annealed and with high-speed tool steel. Under these conditions it should be cut at the rate of 35 feet per minute, the cut being 3/16 inch deep, with 1/16-inch feed. The comparison between the machining of this and other steels is best illustrated by the following table:

TABLE SHOWING CUTTING SPEED FOR DIFFERENT GRADES OF STEEL.
Depth of cut 3/16 inch and feed 1/16 inch.

Kind of Steel.	Cutting Speed in Feet per Minute.	Pounds of Turnings per Hour.
Steel with 0.10 per cent of carbon.........	100	295
" " 0.20 " " " "	75	222
" " 0.30 " " " "	63	176
" " 0.40 " " " "	51	150
" " 3.50 " " " nickel.........	55	163
0.75 per cent nickel, 0.80 per cent chromium, and 0.25 per cent carbon.........	50	148
1.50 per cent nickel, 0.80 per cent chromium, and 0 25 per cent carbon....	45½	135
Steel with 1.5 per cent nickel, 0.80 per cent chromium, and 0.45 per cent carbon.....	35	103

This steel is only used where strength and lightness are more important than cost. In automobile construction, it is only used on the higher priced cars and for the parts which have to stand the largest amount of strains and stresses. Its ability to stand these stresses better than the ordinary carbon steel was demonstrated by one motor car builder, by taking two round bars 1⅛ inch in diameter, one of which was nickel-chrome steel and the other a mild carbon steel, fairly low in carbon, gripping both ends, leaving 9½ inches exposed and subjecting them to a bending operation, the bending being 9/32 inch out of the true position of the center-line of the bars. This bending was made, back and forth, with the carbon steel bar 20,000 times before it fractured, while with the nickel-chrome steel bar 250,000 bendings were made before this fractured. Other tests, which have been made by the writer, show similar results.

With the continued use of this grade of steel, its manufacture in larger quantities by the steel makers, and the improvements in machinery and cutting steels, it will no doubt be cheapened both in the production and in its manufacture into finished products, so that its use can become more diversified, and better wearing qualities, lighter weight and greater strength given to the working parts of many classes of machinery.

METHOD OF HARDENING THIN MILLING CUTTERS.

J. F. SALLOWS.*

Based upon my experience of years in hardening and tempering all kinds of tools, it is my opinion that where there is a quantity of thin milling cutters to be hardened and tempered, they should be arranged on a mandrel, as shown in Fig. 1. This view shows ten milling cutters varying in size from 3 to 4½ inches diameter, all having ½ inch cutting face. They are all arranged on one stud or mandrel, with a washer on each end of such diameter that it allows the cutters to harden to sufficient depth to provide for numerous grindings, and at the same time not harden to such depth as to cause warping or

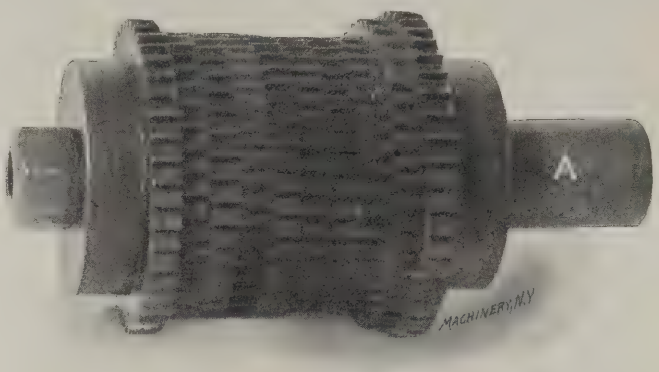


Fig. 1. Thin Milling Cutters Mounted on Arbor for Hardening.

cracking. Cutters 1/16 inch thick and upward should be hardened in this manner, as the method does away with any possible warping, and it insures uniform hardness.

Fig. 2 shows the stud, washers and nut before the cutters are put on the stud for packing. The stud should be of such length at the large end *A* as to permit of a good tong hold A washer is put on first, and then the cutters are put on, followed by the other washer. The nut is tightened as tightly as possible, and the cutters are then packed in a pipe large enough to allow ½-inch clearance between the teeth and the inside of the pipe. They are packed in fine wood charcoal, and the ends of the pipe are sealed with asbestos cement. Heat in a furnace, or if no furnace is at hand, place the pipe over an open fire on a large forge and cover with coal or hard coke. If the pipe does not heat uniformly, roll it over and over. This is an advantage of a pipe over a box for pack-hardening, it being readily turned so as to heat the contents uniformly.

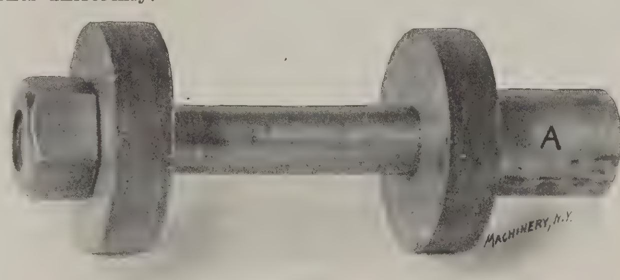


Fig. 2. Arbor used when Hardening Thin Cutters.

The cutters shown in Fig. 1 were dipped at a bright red heat in cold salt water, and while still quite warm were removed to a tank of fish-oil to draw down. They came out straight and were hard from outside cutting edge to within about ⅛ inch above the washer line. This method, in my opinion, is the best way to secure a first-class job of this class of tools when hardened in quantities.

* * *

Some metals will amalgamate when in contact, even when at ordinary temperatures. Gold in contact with lead will permeate the lead for a considerable distance from the point of contact, and it is said that if a zinc disk and a copper disk are held together for a number of months under pressure, that the surface of the copper will be found covered with a film of yellow brass.

*Reo Motor Car Co., Lansing, Mich.

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We solicit communications from practical men on subjects pertaining to railway machine shop practice, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

JULY, 1907.

RAILWAYS AND THEIR OWNERS.

The recent action of the Philadelphia & Reading R.R. in increasing the commutation rates to the commuters of the Philadelphia district, in retaliation for the legislative enactment reducing passenger fares to two cents per mile, is only one more nail driven in the coffin of private ownership of public utilities. It would seem that the old saying, "Whom they would destroy, the gods first make mad," applies with special significance to some of our eminent railway officials. It is a great pity that they do not, or will not, read the sign of the times aright. The old conception that railways are private property to be administered for the sole benefit of the stockholders and the officers is one that had a modicum of support in the past, but now the growth of the idea that railways are public institutions that shall be administered for the public good, without favoritism to any, has grown with wonderful rapidity. That government ownership and operation is near at hand, we would not venture to predict, but that the railways must submit to governmental regulation of an order quite different from that to which they have given contemptuous assent in the past, is very evident to one who pays the slightest heed to the march of events.

Since the above was written the management of the P. & R. has virtually restored the commutation rates that had been in force, and which had been instrumental in building up the numerous suburban communities along its line. The indignant protests of business men and other classes affected could not go unheeded. Such incidents are undoubtedly educational, but they do not reflect very well on the intelligence of certain railway officials, for the education is of a kind that most of us, who are not in favor of absolute government control, would rather not see impressed.

* * *

TO MAKE EMPLOYERS LIABLE FOR ALL ACCIDENTS.

There are more men, women and children killed and hurt in industrial occupations every year than were killed and wounded in any of the four years of our great civil war, the number being estimated at 525,000. Of this number between 90,000 and 100,000 are victims of railway accidents. This great slaughter and maiming is the price we pay for modern civilization, but it is a price that should be regarded as prohibitive, because it is largely unnecessary. There is probably no feature of present industrial activity that requires improvement and reform so much as that which makes so many accidents possible. In the adoption of the automatic car coupler, the railways did more to reduce accidents than by any other step, save the adoption of the air brake. The efficiency of the latter device in preventing accidents and loss of life can scarcely be overestimated. President Roosevelt, in an address delivered at the Jamestown Exposition, June 10, expressed the idea that the railways and all employers of labor can be made to do still better in the prevention of accidents to employes by holding them strictly liable for all accidents, forcing them to make adequate compensation without the necessity of the employes appealing to the courts. In short, he suggested that all employers, whether railways or manufacturers, should, as a matter of business principle, pay their injured employes certain sums, depending on the character of their injuries. "Only in this way can the shock of the accident be diffused, for it will be transferred from employer to consumer, for whom all industries are carried on. From their standpoint the change will be a benefit. The community at large should share the burden as well as the benefits of industry, and the workmen and the workmen's families will be relieved from a crushing load."

* * *

THE NECESSITY FOR DOUBLE TRACKS.

When reviewing the list of our frequent railway accidents, it is impossible to entirely rid oneself of the idea that many of them are caused by the attempt to conduct a two-track volume of business on a single-track road. The volume of traffic on many of the larger systems of the Middle West, those, for instance, which connect Chicago and St. Louis on the one hand, with Cleveland and Cincinnati on the other, compares favorably with that of several double-tracked systems in the East. Yet the majority of these roads are provided only with single track. Not only does this cause undue liability to railway accidents, but even when accidents are avoided, a late train, which must be given the right of way, will demoralize the entire traffic of the road. The service of such roads becomes by necessity poor, and neither efficiency, nor good will, on the part of the railway officials can do much toward improving the service appreciably. The public, however, pays as much or more for this inferior service as it pays for the better service of several double-track roads; and the public has properly a right to demand that such an improvement as this be made, and that at least a somewhat fair equivalent is received for the price paid. Nor would the public alone be the gainer. The railroads, themselves, seem sometimes to be short-sighted in not realizing the loss accruing from such constant delays and demoralization of the service as are common on single-track lines with heavy traffic.

At the present time the excuse will be offered that money is so stringent that improvements cannot be contracted. The need for the improvements mentioned, however, has not grown suddenly upon the railroads. This need was present, even if not in so imperative form, years ago, when both money and labor were cheaper; but at that time the consideration for the public was even less than now, and the railroads were even more short-sighted, anticipating neither the increase in traffic, nor the rising popular resentment to the methods of certain railway managements. The railway traffic of Ohio, Indiana and Illinois, for instance, may, without great exaggeration, be compared with that of Germany. Yet, in the states mentioned, the systems being double-tracked may be counted on the fingers of one hand, while in the latter country the double track is almost exclusively in evidence. It is not improbable that the comparatively low number of railway accidents in Germany is largely due to this fact. Our railway system, once leading the world, now seems to need a new impetus to keep up its reputation. It is not ability or efficiency on the part of our practical railway men we need. They fill their places as well as circumstances permit. But what we do need is less manipulation by unscrupulous financiers.

* * *

An incident which, while on the face of it rather humorous, throws an unpleasant reflection upon the way in which some of our railroads discharge their duties, is related in the *St. Louis Globe-Democrat*. The fact that a car of coal ordered by a Chickasha dealer in October, 1903, did not reach its destination until January, 1907, was recently reported to the office of the Attorney-General at Guthrie, Okla. The carload, it seems, had been on the road for more than three years. If incidents like this are true, it seems easy to explain why some roads are constantly short of cars.

WRITING LETTERS IN A BUSINESS-LIKE MANNER.

It is very common among a certain class of office people to hear criticisms pronounced on explicit letters because of not being written in a "business-like way," the business-like letter evidently being supposed to be one that is short and meager in its wording. This, however, must be considered an erroneous opinion, and is daily causing a great deal of extra work and trouble in business life. The ideal business letter is one which in as short a space as possible clearly transfers the thoughts of the writer to the reader. To do this in very few words is often impossible, and while some men may have a great ability of expressing themselves at the same time clearly and concisely, the majority of letter writers need about as many words to convey their ideas as they feel inclined to use. For this reason it is a mistaken policy to sacrifice clearness of expression to the notion that business letters should necessarily be short. They should be as short as consistent with perfectly clear and definite statements, but not a word shorter, no matter how many pages are necessary for the writer to express his ideas.

It is said that the man at the head of one of our largest machinery firms never reads a letter which extends over more than one sheet of paper. The opinions of such a man necessarily have great weight with his subordinates, and they will eagerly try to make a rule of not writing any longer letters. This gentleman himself may possess a special ability of clear thought and of short expression, but the majority of the clerks and employes of the company lack such an ability and conform to such arbitrary rules only by failing to make their letters convey their ideas. The writer, when in the employ of a large manufacturing concern, had often occasion to make inquiries in regard to certain orders given by customers who could be reached only by writing. A draft of the letter was made, stating the case and asking, as clearly as possible, for the information wanted. In certain cases where the subject in question was complicated it was impossible to confine the matter to a very limited space. This draft was passed in to the business office where the matter was "boiled down," as the expression was, to conform to the rules of business-like letters, and the result often was that two or three letters had to pass between the firm and the customer before plain understanding could be had. This, of course, could all be blamed to the inquirer's way of asking his questions, and not to the "boiling down" process to which the questions had been subjected, had it not been for the fact that in a few cases where the writer's drafts were strictly copied, the information asked for came as expected. All of which is intended to prove that the "business-like" letter, so-called, has its drawbacks.

* * *

GENIUS UNDER CONTRACT.

CHARLES CLOUKEY.*

Some of the most progressive and far-seeing manufacturing and engineering concerns have adopted various forms of profit-sharing policies with the end in view of increasing the interest and efficiency of their working forces. The move is a very commendable one, and, so far as is known, is a successful one, and contrasts very strongly with the contract system of some of the largest and most influential corporations in the United States, in which they bind the employes to give the company all the benefits of their inventive genius.

A published statement not long ago asserted that many concerns maintained a very large corps of inventors, sometimes several hundred or a thousand for a single firm, and these men were employed to invent improvements and appliances in the line of manufacture in which the company was engaged. The facts in the case point to the contract system used by the great Westinghouse interests and many others, in which the applicant for any position signs a contract to assign any and all inventions he may accomplish while in the employment of the company.

There are at least two pernicious features to such a method, the first one being the well-known fact that many capable men find themselves in such stress of circumstances as to make it imperative for them to secure employment, although it involves a mortgage upon their genius; and the second is a tendency to indifference in the matter of invention where there is neither credit nor profit coming to the inventor. Of course, there is occasionally a man who will do his best and spend much of his own time just for the sake of accomplishing something in the world besides his stint of daily toil; but in the great majority of cases there will be an indifference or an effort to evade the contract. Most inventors who have had no experience do not realize the difficulties which lie between themselves and fortune after their patent is a matter of possession, and so they will quit the service or take out the patent in the name of a friend, and then find that the company that would have utilized it in the first case is entirely indifferent to its merits in the second.

So I say, that for several good reasons, the unqualified contract system of the control of inventions is pernicious in its general effect on progress, and does not give the results expected by the party of the first part.

In strong contrast to the foregoing is the system adopted by more progressive and considerate business concerns who ask their employes for ideas on improvements in machinery, appliances and methods, and whenever one of these suggestions is adopted, the author of it is rewarded with a definite sum, due him above the regular wage which he has earned by the performance of his usual duties. These rewards are not of uniform value, but are based upon the relative augmentation of profits following the adoption of the improvement, and in many cases amount to much more than the inventor could have realized had he patented the contrivance and trusted to a sale of the patent. Another commendable feature of this plan is that many ideas of value which are not patentable bring a substantial reward to the workman without extra investment or delay, and perhaps as great profit comes to the firm in the end from the general good feeling aroused in the skilled workman and the common laborer alike, for there is such a vast difference between a man's best service and his grudging toil, that at the same rate of wage one house will go on to prosperity and another will go into bankruptcy.

However, there is one commendable feature common to both of the systems referred to, and that is the encouragement and opportunity for the development of new ideas from the standpoint of physical means. All the machinery and appliances of the firm are at the inventor's service if the invention promises anything worth while, and this is enough to encourage many a man who has an inventive turn, even though he gets nothing extra out of it. But it is a good business principle that holds in mind as well as in merchandise, that whatever is worth using is worth paying for, and many an inspiration has died, reflecting upon this axiom.

The relative value of the two methods will in time become apparent even to the great corporations, and they will adopt that which will pay them best, and as is true in nearly every case, what will pay the employe the best will pay the employer best, and the rule works both ways when there is good feeling and mutual interest between the principals in the labor problem.

* Address: 202 Independence Ave., Enid, Okla.

* * *

A contributor to the *Saturday Evening Post* writes of "millions in old iron," and paints a truly wonderful picture of what is going to happen in the next few years in scrapping existing machinery because of industrial progress. For example, the article states that the scrap iron business leads all other lines of metal trade and is being greatly stimulated by the substitution of electricity for steam by so many railroads of the country. It is estimated (by whom?) that within the next five years 30,000 steam locomotives will go to the junk heap, etc. The steam locomotive has been consigned to the junk heap by several writers and would-be prophets, but this is the first time that we have seen a definite period given for the wholesale consignment of over half the total number in the country. We believe the writer has "another think" coming. If we are not greatly mistaken, there will be more steam locomotives in use in 1912 by many thousands than there are at this date, notwithstanding the growth of electric traction.

ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

New York's new child-labor law provides that no minor under sixteen years of age shall be employed or permitted to work in any factory in the state before 8 A. M. or after 5 P. M. The new law goes into effect January 1, 1908.

In all countries where an abundant supply of water power is available, the question of the electrification of railways is at the front. In Switzerland a report, prepared by experts, is now at hand, which is in favor of the general adoption of electric traction throughout the country.

Steps have been taken to construct, at San Francisco, the largest dry-dock in the world. This dock will be 1,050 feet long, and is to be constructed at the estimated cost of $1,250,000. It will be large enough to hold at once any two ordinary large-sized ocean steamers, the late giants, however, excepted.

It is mentioned in *Engineering* that the longest distance over which the human voice has been transmitted is believed to be from Montreal to Winnipeg, 1,430 miles, over a special copper wire along the Canadian Pacific Railway. This wire was installed by the railway company for its telegraphone system, by means of which two messages—one by telephone and the other by telegraph—can be transmitted simultaneously over the wire.

An interesting novelty that has been on the market for a few years is a magnetic incandescent lamp holder, chiefly intended for use in machine shops. The holder is made with a base which is magnetized when the lamp is burning. The magnetized base holds the lamp firmly to any iron portion of a lathe, planer, drill or other machine tool so that the light may be held and directed exactly where required. The convenience and novelty of the device, together with its simplicity, makes the beholder who first sees it wonder why the idea was not thought of long ago.

The gun trade of Birmingham, England, which city was for a long time the most important center for this industry in the world, has of late years declined, while at the same time the gun-making factories of Liége, Belgium, have greatly increased. It is stated in *L'Echo de L'Industrie* that, while the number of gunsmiths in Birmingham in 1860 was 16,840, there are now only about 4,000, while at the present time the number of gunsmiths in Liége is 40,000. About thirty years ago England possessed more than half of the gun trade of the world. Now Belgium has acquired 65 per cent of that trade, and is able to reckon England among her best customers.

In a report regarding the government railroads of Germany, Consul-General Richard Guenther says that the Prussian State railroads, after payment of the interest of the debt, showed an excess of earnings over expenditures in 1905 of $119,830,000, and in 1906, $134,520,000. A showing like this, amounting to a net profit of from 6 to 6.65 per cent of the actual capital expended, after the payment of interest, well indicates the possibilities of government ownership of railroads, and when the low passenger rates, the comparatively low freight rates, and the high standard of service of German railroads is considered, the financial results are the more surprising.

Recognizing the need of a business education, as well as a technical training, for engineers, a course in business practise has been instituted at the technical institute at Danzig, Germany. It has always been the practise in European technical schools to give a limited instruction in bookkeeping and ordinary business practise, but the course in question is to be more complete in its scope. It is beyond doubt that this move will prove of great value, and it would be highly commendable if higher technical institutions in this country adopted this idea. The technical graduates from our foremost technical colleges are almost certain to sooner or later be placed in a position where a business education, specially adopted for the man of technical training, would be of great value.

It is reported by *The Engineer*, Chicago, that tests recently made by Prof. H. B. MacFarland, of Armour Institute, on a concrete girder, 18 x 18 inches, with five 1⅛-inch iron rods bedded in the bottom, showed that, when exposed to heat, the girder began to deflect at a temperature of 640 degrees F. This deflection continued throughout the test, reaching 5 inches in three hours, the temperature being somewhat less than 2,000 degrees when at its maximum. The length of the girder between supports was 16 feet 6 inches. Loads were applied at 6 feet 1¾ inch from each end by means of jack screws seated against car springs bearing on brick piers, 2.5 tons being applied at each loading point. After the fire was extinguished, the deflection continued with the load decreasing until the deflection was 8 3/16 inches and the load 0.75 ton.

In our November, 1906, issue we mentioned the installation of an electric steel melting furnace in the works of Henry Disston & Sons, at Tacony, near Philadelphia, Pa. The success with this furnace has been so great that the company is now considering the installation of a much larger electric furnace plant. The furnace which is at present in operation was manufactured by the Induction Furnace Company of America, Philadelphia, under patents of Mr. Edward A. Colby. Henry Disston & Sons have been the pioneers in the introduction of the electric induction furnace practise for the manufacture of high-grade crucible steel. In Europe as well, the continuous induction furnace for electric smelting is making great strides. The latest construction is one brought out by Mr. Albert Hiort, a Norwegian engineer. This furnace applies the same principles as the others of its class, and its novelty is to be found merely in its design.

One of the most radical departures in the way of taking care of a country's natural resources, but at the same time one of the most hopeful signs of our commercial era, is that of the Swedish government having adopted a plan of taking over the immense iron ore deposits in the northern part of that country. The private company, which is at the present time working the mines, will have the right of exploitation for 25 years to come, but will meanwhile be permitted only to mine a certain definite amount of ore. After that time the ore lands will be transferred to the State. The aggregate amount of ore in these ore lands is estimated at from 500,000,000 to 800,000,000 tons. In view of the fact that natural deposits of this kind are plainly the property of the nation as a whole, and cannot consistently be left to enriching private individuals, in no way responsible for the existence of these deposits, it is gratifying to hear that some statesmen are recognizing the necessity of asserting the right of the people to the bounties of nature, at the same time as the prevention of a monopoly assures of a greater impetus to competitive industrial development.

The present high standard of shipbuilding, as far as safety is concerned, has perhaps never been more plainly demonstrated than in the case of the salvage of the White Star liner *Suevic*, which some time ago ran full speed upon a submerged rock outside of the Scilly Islands. It was found impossible to take the ship, which registered 12,500 tons, off the rock. It was therefore decided to leave the fore part of the ship, which was fast on the rock, where it was, and sever it from the after portion which contained the most valuable parts of the ship, her engines, boilers, etc., and by so doing save this part. A continuous line of dynamite cartridges were carried around the vessel, electric connection made to a distant point, and the cartridges exploded. The action of the dynamite cut the steamer in two, and two-thirds of the vessel floated away intact, this being made possible by the several

water-tight sections with which all modern steamers are built. The *Suevic* was taken to Southampton for repairs, presumably for being provided with a new bow instead of the one she left on the rocks of the Scilly Islands.

Users of gas engines on a large scale are commencing to realize that the heat carried away by the exhaust from gas engines amounts to about one-third of the total heat generated, and that the exhaust gases, being at a temperature of about 1,000 degrees F., are capable of raising a large amount of steam, provided that a boiler suitable for the purpose is installed. According to the *Railway and Engineering Review* such boilers are now being placed on the market. They should be placed as near to the engine cylinder as possible, and they consequently form a perfect exhaust silencer. When the gases have passed through the boiler they escape into the atmosphere by a pipe which is free from the usual nuisance of heat and noise. Inasmuch as gas power has not so far been favorably considered in many plants because of the need of the exhaust steam from steam engines for special purposes, there is now a chance for the adoption of the exhaust gas boiler to raise steam for heat or other purposes, while the motive power is gas, and thus a double measure of economy and usefulness is attained. In one factory in England these boilers are generating steam from the heat of the gas engine exhaust gases equivalent to the steam generated by 70 tons of coal per week.

After having undertaken experimental electrification of short railway lines, the Swedish government seems to be intending to put electricity to use on the Swedish State railways on a scale not having yet been attempted elsewhere. In *Teknisk Tidskrift*, of May 4, we find a complete plan for the electrification of the State railway system in the southern part of the country, comprising a length of lines of about 1,300 miles, the electric power for which would be supplied from five power stations, all, for the generation of power, making use of some of the numerous water falls of the country. The financial possibilities have been considered, and it is stated from good authority that the electrical working of the State railways would offer a saving in operating expenses. At the same time a better and more convenient passenger service could be installed. In Germany, the electrification of a line from Hamburg to Kiel, about sixty miles long, is under consideration, this line being intended to be an experimental one, on which estimates for electrification on a larger scale could be based. Norway is also planning for using the power of its water falls for the generation of power for its State railways, and a small portion of these railroads is to be electrified for experimental purposes there as well. These projects for electrification do not only include electric power for passenger service, but the freight service is to be placed on the same basis also.

The following is the color scheme adopted in the power plant of the Pennsylvania, New York & Long Island Railroad Co. in Long Island City, N. Y., which was devised by Westinghouse, Church, Kerr & Co.:

White—High-pressure steam lines.

Bright red—Drips from superheated steam lines, including the Holly system and connection to boilers.

Bright red with black flanges—Saturated steam lines and Holly system connection.

Yellow—Exhaust from auxiliary apparatus and low-pressure drip lines.

Black—Boiler feed piping from boiler feed-pumps to boiler drums, including heaters, economizers, and their connections.

Blue—All water piping, except the boiler feed lines and fire lines.

Structural color—Fire protection system; painted to match the structural steel to which it was adjacent.

Maroon—Blow-off piping.

Green—Air lines.

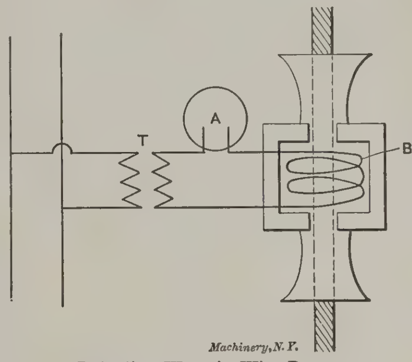
Slate—Crank-case oil piping between engines and separators.

Brass—Unpainted, all oil lines except those painted slate color.—*Engineer*.

APPARATUS FOR DETECTING WEAR IN WIRE ROPES.

C. McMann, before the Transvaal Institute of Mechanical Engineers.

An apparatus for detecting variation in the cross sectional area or wear in wire ropes was described recently at a meeting of the Transvaal Institute. The illustration shows the scheme of the apparatus. An alternating current passes through a transformer *T*. The secondary of the transformer is connected to a coil *B*, through which the wire rope to be tested is threaded. This coil *B* may be designed to open up, enabling it to be applied to a rope without the trouble of threading the rope through it. At each end of the coil proper are bell mouths, which are to guide the rope into the coil. The coil is also enclosed in a laminated iron cylinder to concentrate the magnetic field within it. An ammeter *A* is inserted in the secondary circuit. When there is no rope inside the coil *B*, the self induction is low, and the current consequently is large. On introducing the rope, the induction is increased and the current falls exactly in proportion to the size of the rope so introduced. In practical use, the rope is threaded through the coil *B*, and slowly passed through it, the person in charge of the test watching the ammeter, the reading varying in direct proportion to any decrease in cross sectional area of the portion of the rope at that moment in the coil. Thus the exact amount of wear on the rope can be determined direct from the ammeter readings. If so desired, the ammeter may be of the recording form, thus obviating the necessity of an observer watching it during the time of the test.



Detecting Wear in Wire Ropes.

PROPER PACKING.

Daily Consular and Trade Reports, March 14, 1907.

Mr. Paul Roux, a member of the American Chamber of Commerce in Paris, calls attention to the necessary requirements for proper packing for trans-Atlantic shipments. Particular stress is laid on the following points. The machines should be more or less completely dismantled before packing; attention must be given to the resistance of the tool and its various parts to rough handling in transportation. It must be remembered that a packing case must protect the machine not only against pressure and blows which it may receive in a normal position, but also protect the machine against abnormal stresses resulting from overhanging position or overturning. No part of the machine should be in contact with the sides of the case unless the sides are made strong enough to withstand the pressure, should the full weight of the machine be thrown upon them. Feet of lathes, beds, and similar parts are frequently broken by the packing case falling even lightly on one of its corners, even when the case itself shows no external evidence of a fall. An important consideration in packing a machine for trans-Atlantic shipment is its volume when packed. Marine freights are generally figured at so much per ton weight, or per 40 cubic feet volume, at the option of the carrier. The exporter has, therefore, an interest in seeing that the weight, which, of course, remains constant, does not occupy a space greater than 40 cubic feet per ton. Nearly all machines, however, if not dismantled and compactly packed, make up into packages greatly exceeding 40 cubic feet per ton. When dismantling, on the other hand, it must be remembered that parts requiring accurate adjustment, and which are difficult to assemble, should be left intact, and the exporter must use his best judgment in such respects.

In designing the packing case, it is very necessary to make provision for the examination of the machines in a foreign custom house. An opening should be provided on the side of the case, or in the cover, through which the nature of the

machine may be readily seen. This opening must be large enough to permit the examination of all parts of the interior of the case, and to permit the passage of a lantern if required. The cover should be secured with screws and not with nails. Attention is especially called to the fact that packing cases should not be lined with paper. Such a lining prevents the circulation of air, and if the machine is packed in a damp atmosphere, the humidity, which under other circumstances would have evaporated, will attack the finished parts, however slightly exposed. Special attention is called to this point, because experience has demonstrated that injurious results frequently occur. Finished parts must be carefully protected with a coating for preventing rust, as often the machines are subjected to rain, and always to dampness, and a machine may remain during many months in a warehouse before being unpacked. Unless finished surfaces are carefully protected by a coating, injury is almost certain.

The subject of proper packing was treated at length in an article in MACHINERY, April, 1904, by Mr. Paul Roux, and we refer to this for more detailed statements. The previous notes, however, give the most important points, and cannot be too strongly impressed upon exporters of machinery, particularly such as are not engaged in a very large exporting business, and consequently more or less unfamiliar with the conditions and requirements.

CENSUS OF METAL-WORKING MACHINERY.

Bulletin 67, Department of Commerce and Labor.

The census of metal-working machinery, 1905, prepared by Mr. Fred. J. Miller, expert special agent, gives a comprehensive view of the extent and the distribution of the manufacture of metal-working machinery in the United States. The term "metal-working machinery" does not include machines or tools for use in the hand trades, such as plumbers' and tinsmiths' tools, and watchmakers' lathes and tools, or rolling mill machinery, cranes, hoists, etc., but merely what is ordinarily termed machine tools and small tools. The last census of this kind was taken in 1900, and the report gives a comparison of the figures in that year with those in 1905, and also states the percentage of increase of the value as well as of the number of machines being built. The greatest production of metal-working machinery at the census of 1905, which, in fact, records the figures for the year 1904, was reported for Ohio, which state also stood first in 1900. The value of metal-working machinery manufactured in Ohio forms not less than 25 per cent of the total value of all metal-working machinery manufactured in the United States, and is greater than the combined product of New York, New Jersey and Pennsylvania. As is well-known, this industry in Ohio is concentrated in Cincinnati and Cleveland, which two cities together produced three-fourths of the total value of all metal-working machinery in the state, or nearly one-fifth of all the metal-working machinery manufactured in the United States. Cincinnati is the leading city in the country in this industry, producing, as it does, almost exactly one-tenth of all the metal-working machinery of the country. Massachusetts is the second state in the union in regard to the value of its machinery products, Worcester being the leading city in that state. Connecticut takes the third place, the leading manufacturing city for this class of machinery being Hartford. New York State takes the fourth place, and New York City is the third city in the United States in regard to the value of production, the bulk of its manufacture being located in Brooklyn. Pennsylvania, which was the second state in the manufacture of metal-working machinery in 1900, sunk to the fifth rank in 1905, but Philadelphia retained its fourth place amongst the cities of the United States. The fifth city in this respect is Providence, producing 86.2 per cent of all the machinery of Rhode Island, which is the seventh among the states of the country in this industry, the sixth place being held by Illinois.

In regard to the class of machinery manufactured, the census shows that while lathes are the principal class of metal-working machinery the value of this product as well as the number of machines decreased most remarkably during the five years since the last census. Ohio ranked first in the production of lathes, reporting about one-third of the total number and more than two-fifths of the total value. The production of milling machines showed a slight decrease in regard to the number of machines manufactured, but there was an increase in the value of such machines of 14 per cent. Rhode Island and Ohio ranked first as the leading states in the manufacture of these machines. A remarkable increase is shown under the heading "All other metal-working machinery not specified," which includes small tools, chucks, precision tools, and special machines for duplicate parts. The total value for small tools for metal-working machinery manufactured in the United States in 1904 was more than one-seventh of the total for all classes of metal-working machines. In the census, only tools for use in power-driven machinery are reported as small tools, but it is possible that some hand tools have been included. However, as there may be some manufacture of this class of apparatus not reported, it is probable that the figure given is a fairly accurate report of this branch of manufacture. The value of special machinery for the manufacture of duplicate parts, and special machinery not specified, amounted to more than one-tenth of the total of all metal-working machinery. Massachusetts was the principal state in the manufacture of small tools, and also in precision tools and machines, with Connecticut second in rank in the former, and Rhode Island in the latter manufacture.

If the foreign trade in iron and steel manufacture and machinery may be taken as an index of the condition prevailing in the various branches of that industry, the figures of the census clearly show that the manufacture of metal-working machinery was somewhat depressed during the five-year period recorded by the census. The exports of iron and steel manufacture and machinery decreased steadily, year by year, from 1900 to 1903 inclusive, and although in 1904, when the business conditions in this country were improving in the iron and steel industry, the increase in exports was materially greater than the years preceding, the exports in that year still were considerably less than those of 1900.

While the total production of metal-working machinery in the census of 1905 shows an increase as compared with the census of 1900, it must be remembered that the statistics of the latter year were not as complete as those of the former.

GAS ENGINE POWER CHART.

L'Automobile, July 29, 1905.

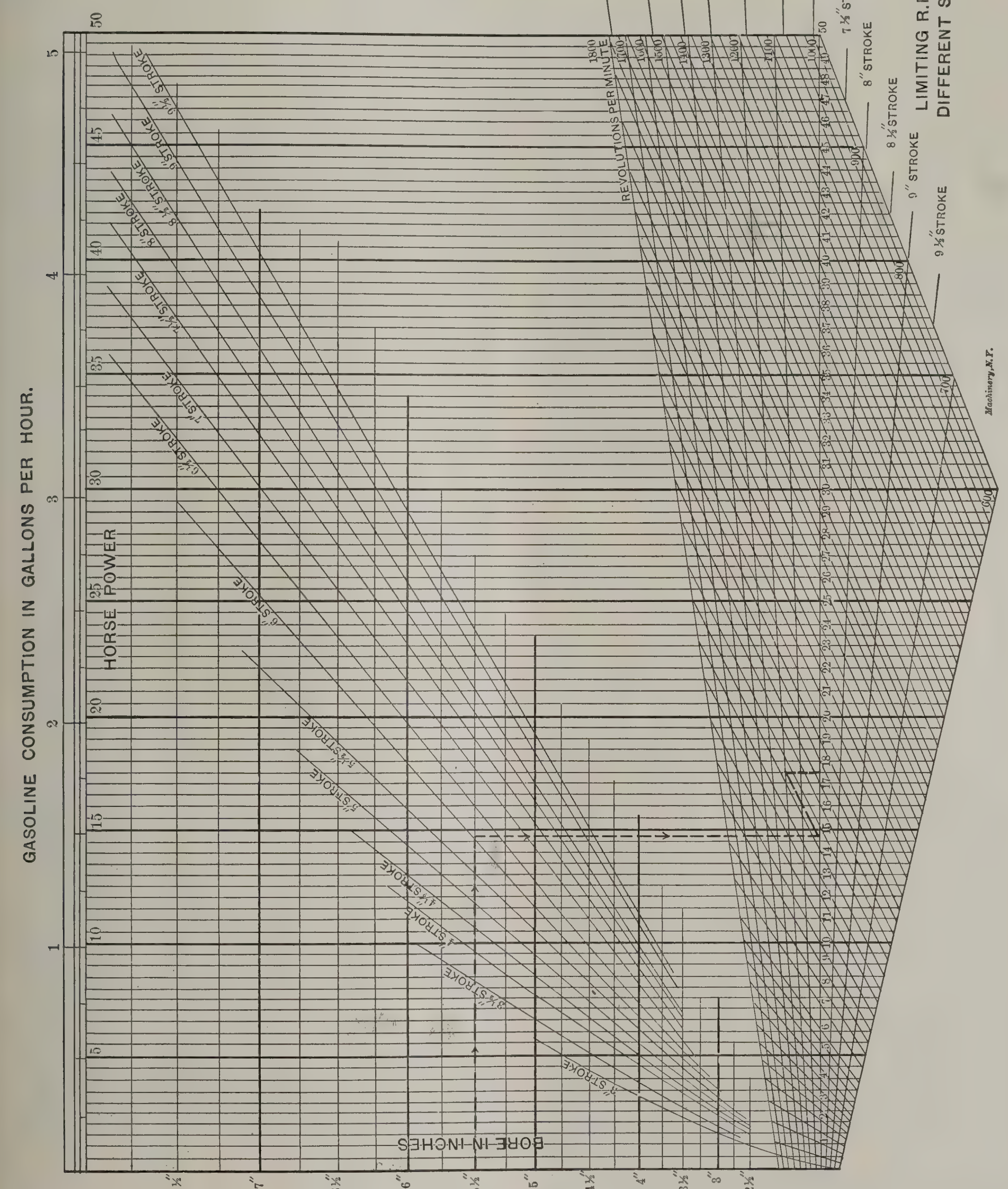
The accompanying chart is of great value to a gas engine man as it enables him to quickly arrive at the power of a motor. The original curves were given with bore, stroke, horse-power, gasoline consumption, etc., in metric denominations; these have been transposed into English equivalents.

The bores (in inches) are represented by ordinates at the left-hand side (straight horizontal lines), including diameters from 2½ to 7¾ inches. The stroke of the motor is shown by the curves in the top section of the diagram, which include from 3 to 9½ inches. The revolutions per minute (R.P.M.) are shown by a series of diagonal lines in the lower section of diagram, numbered 600 to 1,800, inclusive. There is for a motor a limit of R.P.M. above which the horse-power does not increase proportionally to its R.P.M. To this end the diagram shows on the right the limit of the R.P.M. corresponding to the different strokes. Thus, the results of this table are accurate only for a motor with a 5½-inch stroke from 600 R.P.M. up to 1,300 R.P.M., the limit 1,300 R.P.M. being read opposite "5½-inch stroke" in the lower right-hand corner. The method of using the table is as follows:

Given: The bore, 5½ inches; stroke, 6 inches of a four-cylinder engine. To find the maximum horse-power and normal amount of gasoline consumed per hour.

First find the maximum R.P.M. for the given stroke by looking opposite the stroke 6 inches in the lower right-hand corner. This will be found to be about 1,200 R.P.M. Follow the horizontal line corresponding to 5½-inch bore until it intercepts the curve corresponding to 6-inch stroke. From this point draw a perpendicular down to the H.P. line (1,000 R.P.M.) when we read by interpolation 14.6. The line corresponding to 1,200 R.P.M. (the maximum) is above the 1,000 R.P.M. or H.P. line, so follow the diagonal line from the point

14.6 *upward* and to the *right* until it intercepts this 1,200 R.P.M. line, where drawing a perpendicular line again to the H.-P. line, from this intersection, will give us approximately 17.5 H.P. for one cylinder at 1,200 R.P.M. For the four cylinders, multiply by 4, arriving at 70 H.P.



At the top of the diagram perpendicularly above the 17½ H.P., we find 1.8 gallon per hour gasoline consumption, which multiplied by 4 gives 7.2 gallons per hour.

If the power of this motor were wanted at 700 R.P.M. instead of 1,200, follow a diagonal line *down* and to the *left* from the point 14.6 on the H.P. or 1,000 R.P.M. line, and at its intersection with the 700 R.P.M. line go perpendicularly upward again to the H.P. line, arriving at 10.3 H.P. for one cylinder; 10.3 × 4 = 41.2 H.P. for four cylinders.

The same process is followed with any dimension of cylinder within the limits of this table, arriving at fairly accurate results.

Of course these curves are limited to gasoline motors of the four-cycle type, which run at a moderately high speed or, in other words, will give the average practise for modern motor car and motor boat engines. It will also be understood that the H.P. of different motors by different makers, and even the same makers, will vary, due to different points in design, setting of valve and ignition cams, carburation, etc., as much as 5 per cent above and below the results arrived at through the use of this diagram. The diagram was made to be read with the left side (as here shown) at the top, and the directions are worded for this more convenient position when in use.

L. R. G

A PLEA FOR HEALTHFUL CONDITIONS IN THE BRASS INDUSTRY.

Paper read by Mr Walter B. Snow before the American Foundrymen's Association Convention, Philadelphia, May 21-23, 1907.

In much of the early work done for the welfare of the employe there was a strange confusion of motives. But out of this confusion has now grown a definite recognition of the purely economic advantages of surrounding the workman with healthful conditions. While some other industries are more directly harmful to the health than is the brass industry, there is, nevertheless, ample opportunity within its field to greatly improve the conditions. While the heat and the fumes are primarily uncomfortable, and only secondarily injurious, the greatest harm is done by the dust which is inhaled. This dust is usually of mineral or metallic origin, resulting from the grinding, polishing, tumbling and sandblasting processes

Fig. 1. Dust Collector Discharging into Open Yard.

It is commonly recognized that life is shortened by working in a dust-laden atmosphere, but the extent to which some industries are injurious is startling. In the cutlery and tool industry, which is declared to be one of the most dangerous of trades in this class, the average age of the operatives at death is exceedingly low, and in establishments conducted without proper hygienic precautions, sound men are rare after a few years' work. The prevailing cause of death is consumption, which usually overtakes a susceptible worker so early that his period of usefulness does not extend much beyond five or six years, except where the health is properly safeguarded. The testimony of physicians is that of those employed in this industry nearly all who reach the age of forty die of consumption, excepting those who succumb to some acute disease. As proof of this statement, it is instructive to note that in Northampton, Mass., an important seat of the cutlery industry, the death rate from tuberculosis for the entire male adult population was 2.9 per thousand, while that for the cutlers of that town was four times as great, or 11.8 per thousand. The trouble lies not so much in any directly poisonous results from inhaling the dust as in its power to bring about constant irritation, which produces such a condition of the mucous surfaces that they more readily admit of invasion by disease germs. Fortunately, brass is less irritating than steel, and consequently the results in the brass industry are not as disastrous as they are among the cutlers. But the dust of corundum and emery is peculiarly irritating, and the brass workers' surroundings are therefore susceptible of marked improvement.

The unhygienic conditions existing in the various industries have received the attention of State Boards of Health, whose official investigations are bringing about the passage and enforcement of more stringent laws looking to the safeguarding of the health of the employes in all industrial establishments. In a word, advance has been made from a matter of individual interest to one of almost national importance. The statute books of the leading states of the Union already contain laws, usually somewhat vague in their expression, which require cleanliness, light, warmth, ventilation, and the introduction of specific devices for removing dust, fumes, and the like. While the first impulse of the manufacturer may be to resent the enactment of further laws, yet his compliance with them is not without eventual advantage. Not only will a better class of men prefer to work for him if improved conditions are provided, but there will be far less interference with work because of sickness, more energy in the work which is done, and less loss by death of the potential value possessed by the man who has become thoroughly skilled in a given line of work. Continued sickness and death naturally mean constant replacement of individuals, with the loss of knowledge and skill gained by those who have gone. As a result there is far less stability of labor conditions in an unhealthy industry.

Experience has shown, and the reports of investigations confirm the fact, that mechanical means are absolutely necessary to maintain a rapid air change or to insure proper removal of dust. In fact, the fan blower figures everywhere as the only device adapted to secure these results. It is manifest that the action must be positive, and of sufficient intensity to create ample movement of air. Where there is but little dust or the requirements of ventilation are slight, a fan applied for mere renewal of air throughout the entire extent of a room will meet the requirements. When warranted by the size of the plant, the fan may form part of a blower heating system, by means of which warm air from a centralized heater is delivered under pressure through pipes to all parts of the building. In overheated rooms, and particularly for summer ventilation, the disk or propeller type of fan meets the requirements if placed in wall or ceiling. Wherever dust or fumes are formed locally, as in connection with grinding and polishing wheels, tumbling barrels, or furnaces, the exhaust should be direct from hoods which enclose the objectionable source as completely as possible. In a word, prevention is better than cure. The objection which is often shown by workmen to hoods and similar contrivances, even to the extent of actual destruction, is largely due to their improper construction. In fact, the cause for condemnation or criticism of many exhausting systems lies in the method of application of the fan, and not in the fan itself. The success of the fan not only depends upon its speed and its proper proportioning to the work, but also upon the system of piping and hoods which would give the greatest efficiency. It seems so simple to employ a local tinsmith to rig up an exhausting system that it is not strange that unsatisfactory conditions result. It is far better policy, however, to secure the best advice, which will always be freely given by blower manufacturers, and then have the thing done right. It must not be overlooked that the installation of an economical exhausting arrangement requires definite engineering ability, and experience in this particular class of work.

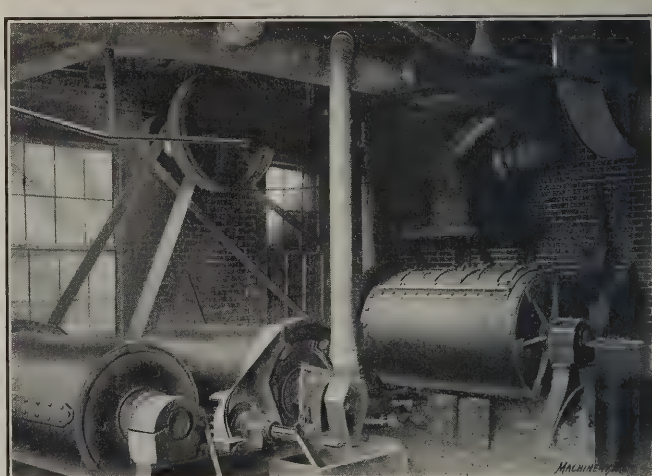


Fig. 2. Exhaust System for Tumbling Barrels.

Because of the lower first cost, the user is always strongly tempted to buy the smallest apparatus that can be made to do the work. But first cost is only one of the factors in the total cost. Large, slow running fans with ample pipe areas are conducive to small power expenditures. It is easy to save enough in power in six months to pay the additional cost of a more efficient outfit or system. Thereafter its economy is all clear gain. Even though the fan be of ample size when first installed, it may, as a result of speeding up to meet added re-

quirements, frequently demand from 50 to 100 per cent more power than would be necessary to do the work with a proper outfit. It is none too generally understood that the power required to drive a fan increases as the cube of the speed; in other words, that doubling the speed calls for an eight-fold increase in power, while twenty-seven times the power is required at three times the speed; an increase of only 25 per cent in speed calls for nearly double the power, and yet such an increase is common enough. How long would it take to pay for a new outfit from the money thus squandered in power?

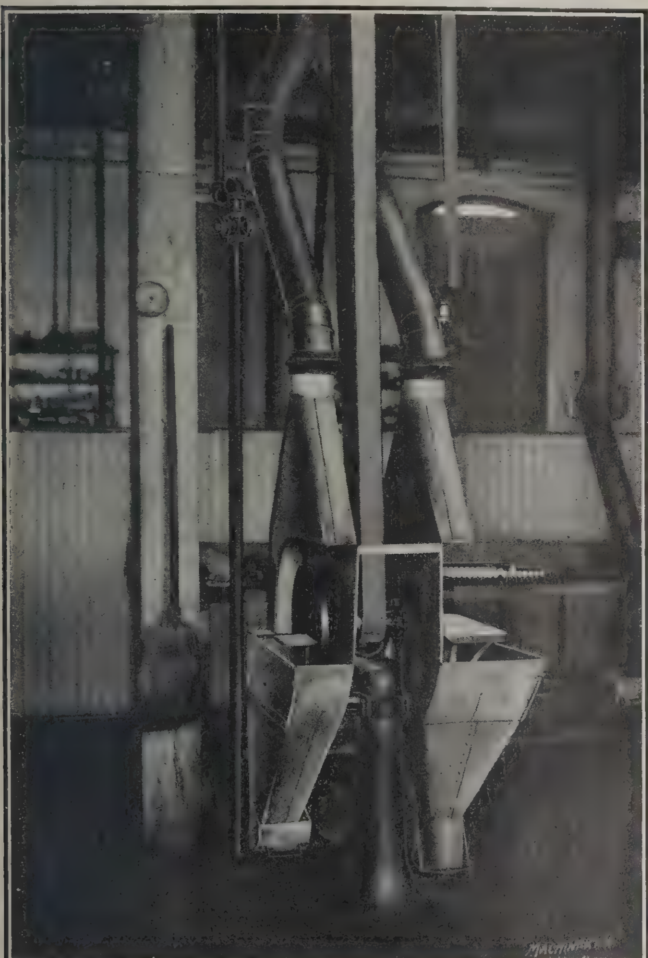


Fig. 3. Exhaust Hoods on Disk Grinder.

The designs of hoods for grinding, polishing, or buffing wheels are many and varied. Each must be arranged to suit the particular class of work for which the wheel is used. In some cases it is even necessary to have several different types in the same room. This is true where the pieces are of such shape and size that it is impossible to get very close to the wheel, the result being that at one time the operator uses the wheel at a point near the top, and again at a point directly underneath. Under these conditions especial care must be taken to provide the most effective type of hood and maintain the maximum blast. In heavy work of this type the air suction pipe should be 5 inches in diameter for wheels up to and including 16 inches in diameter by 3 inches face. In ordinary grinding and buffing rooms the suction pipes should be 4 inches diameter for wheels 2½ inches or less in width and from 10 to 18 inches in diameter. Wheels ranging from 19 inches to 28 inches should have 5-inch or 6-inch pipes according to class of work for which they are used. All hoods should be so designed that the velocity through the openings should not be less than 5,000 feet per minute, which is usually sufficient to create the draft necessary to carry away the particles. The best general type of hood is provided with a receptacle below to trap out all heavy particles, as well as the threads from the buffing wheels, while allowing the finer dust to pass through the pipe. The result is that the metallic particles are left in clean condition ready for resmelting, and the wear on the pipes and the fan is greatly reduced. This arrangement also prevents the annoyance caused by the dust from the rag wheel adhering to the fan wheel and throwing it out of balance. The trapping-out feature, furthermore, permits of the ready recovery from the bottom of the hood of any small piece of work or other material, which with other types of hoods might get into the main trunk line or up into the fan. All properly designed systems should have clean-cut caps so as to provide free access to the interior of the piping. The main suction pipe should be proportionally increased in size as each connection is made to it.

To secure the most economical results, a fan should be chosen which has an area of inlet about twice the combined area of the inlet pipes. This proportion will give the maximum velocity through the branch pipes and hoods. The fan should then be operated at about 1½-ounce speed, under which condition it would consume about ½ horse-power for each 4-inch opening. The most work is done, and consequently the most power is required, by a fan when it is discharging with free inlet and outlet. The more extended the system of piping, the smaller the area of inlet or outlet; and the greater the friction, the less will be the volume delivered by the fan; and consequently the less will be the power required to drive it. It is therefore manifest that the fact that the fan is consuming but little power is not always evidence of its successful operation, for it may be doing little effective work. The dust which is collected by the fan should be discharged into a centrifugal dust collector. Here the dust is separated from the air by centrifugal force; the air escapes from the top practically free from dust, while the dust itself drops out of the bottom through a pipe. It should be periodically removed. The dust from wheels grinding iron and steel should not be mixed with that from rag wheels, for in some cases fire will result. Separate fans and systems should be used.

The same general principles hold in connection with systems exhausting from tumbling barrels. If the maximum effect of the fan is desired on tumbling barrels equipped with hollow trunnions, the area of fan inlet should be about double that of the sum of the openings in the trunnions. The sizes of

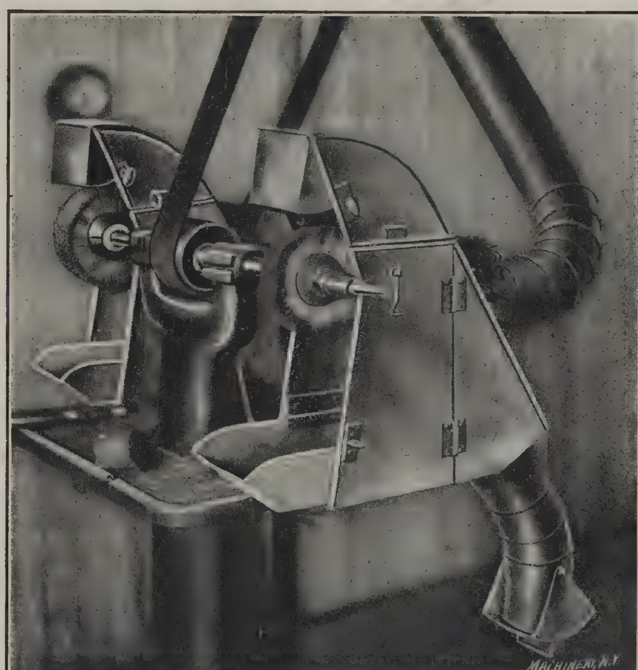


Fig. 4. Hood for Buffing Wheels.

pipes and the speeds of fans to be applied in connection with housed rattlers must depend largely upon the conditions, but a 6-inch pipe connection will usually serve for each tumbling barrel, if the same is tightly enclosed. A fan running at about 1 ounce speed, will give sufficient draft. No general rules can be given for the application of the fan system to sandblast rooms or apparatus. The arrangement must depend entirely upon local conditions. With installations such as are here described, it is possible to maintain a relatively healthy atmosphere, which is bound to insure better work, and there is certainly no reason why healthful conditions should not be found wherever the brass industry is pursued.

ON THE ART OF CUTTING METALS.—7.*

FRED. W. TAYLOR.

COOLING THE TOOL WITH HEAVY STREAM OF WATER.

Cooling the nose of a tool by throwing a heavy stream of water or other fluid directly upon the chip at the point where it is being removed by the tool from the steel forging enables the operator to increase his cutting speed about 40 per cent. The economy realized through this simple expedient is so large that it is a matter of the greatest surprise that experimenters on the art of cutting metals have entirely overlooked this source of gain. In spite of the fact that (as a result of our experiments) the whole machine shop of the Midvale Steel Company was especially designed as long ago as 1893 for the use of a heavy stream of water (supersaturated with soda to prevent rusting) upon each cutting tool, until very recently practically no other shops in this country have been similarly equipped. The following are the important conclusions arrived at as to the effect on the cutting speed of cooling the tool with a heavy stream of water.

A. With high speed tools a gain of 40 per cent can be made in cutting steel or wrought iron by throwing, in the most advantageous manner, a heavy stream of water upon the tool.

B. A heavy stream of water (3 gallons per minute) for a 2-inch by 2½-inch tool and a smaller quantity as the tool grows smaller, should be thrown directly upon the chip at the point where it is being removed from the forging by the tool. Water thrown upon any other part of the tool or the forging is much less efficient.

C. The gain in cutting speed through the use of water on the tool is practically the same for all qualities of steel from the softest to the hardest.

D. The percentage of gain in cutting speed through the use of water on the tool is practically the same whether thin or thick chips are being removed by the tool.

E. With modern high-speed tools a gain of 16 per cent can be made by throwing a heavy stream of water on the chip in cutting cast iron.

F. To get the proper economy from the use of water in cooling the tool, the machine shop shouid be especially designed and the machine tools especially set with a view to the proper and convenient use of water.

G. In cutting steel, the better the quality of tool steel, the greater the percentage of gain through the use of a heavy stream of water thrown directly upon the chip at the point where it is being removed from the forging by the tool. The gain for the different types of tools in cutting steel is:

a. Modern high-speed tools, 40 per cent;
b. Old style self-hardening tools, 33 per cent;
c. Carbon tempered tools, 25 per cent.

This fact, stated in different form, is that the hotter the nose of the tool becomes through the friction of the chip, the greater is the percentage of gain through the use of water on the tool.

The Portion of the Tool upon which the Water Jet should be Thrown.

A series of experiments has demonstrated that water thrown directly upon the chip at the point where it is being removed from the forging by the tool will give higher cutting speeds than if used in any other way.

As another illustration of the small value to be attached to theories which have not been proved, we would cite the following: After deciding to try experiments upon the cooling effect of water when used upon a tool, it was our judgment that if a stream of water were thrown upward between the clearance flank of the tool and the forging itself, in this way the water would reach almost to the cutting edge of the tool at the part where it most requires cooling, and that, by this means the maximum cooling effect of the water would be realized. We, therefore, arranged for a strong water jet to be thrown, as shown in Fig. 46, between the clearance flank of the tool and the flank of the forging, and made a series of experiments to determine the cooling effect of water with various feeds and depths of cut. So confident were we of the truth of this theory that we did not deem it worth while to experiment with throwing streams of water in any other way, until months afterward, when upon throwing a stream of water upon the chip directly at the point where it is being removed from the forging by the tool, we found a material increase in the cutting speed, and thus our first experiments were rendered valueless. Practically, great difficulty will be found in getting machinists in the average shop to direct the stream of water on to the chip in the proper way as indicated in Fig. 47, because when a sufficiently heavy stream of water is thrown upon the work at this point, it splashes much more than when thrown upon the forging just above the chip; and the machinists prefer slower cutting speeds and less splash.

Forty Per Cent Gain in Cutting Speed from Throwing a Heavy Stream of Water upon the Tool in Cutting Steel.

It has been customary for many years to use under certain circumstances, a small trickling stream of water upon cutting tools (mostly on finishing tools, and with the object of giving the work what is called a "water finish"). For this purpose a small water can is generally mounted upon the saddle of the machine above the tool, and refilled from time to time by the machinist. Such streams of water, however, have little or no effect in increasing the cutting speed, because they are too small in volume to appreciably cool the nose of the tool.

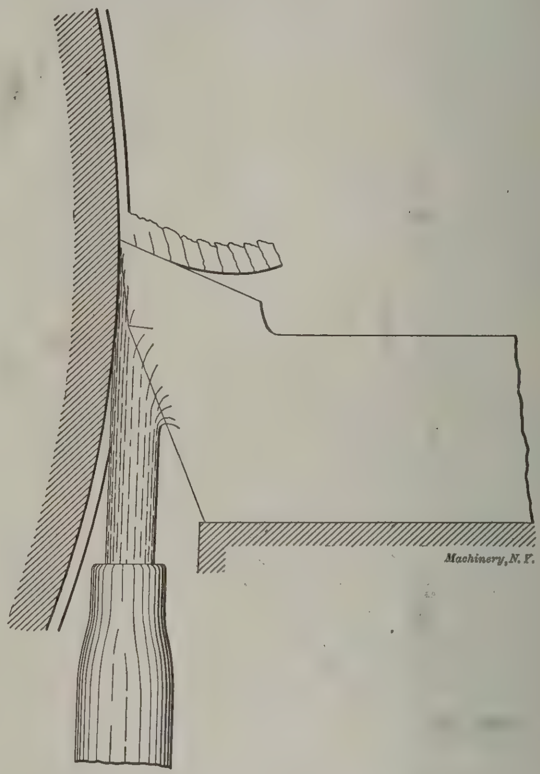


Fig. 46. Discarded Method of Throwing Water on Tool.

The most satisfactory results are obtained from a stream of water falling at rather slow velocity, but with large volume, at the proper point upon the tool, since a stream of this sort covers a larger area of the tool and is much freer from splash.

This water supply should be delivered through pipes fitted up with universal friction joints, so that the apparatus can be quickly adjusted to deliver the water at any desired point (the pipe being supported by a rigid bracket attached to the saddle of the lathe, preferably on the back side so as to be out of the way). In the case of short lathe beds the water supply can be delivered from overhead through a rubber hose, and in the case of long lathe beds through telescoping pipes attached to the saddle (smooth drawn brass pipes telescoping inside of ordinary wrought iron pipes, with suitable stuffing boxes, being used).

About three gallons of water per minute are required for adequately cooling a very large roughing tool, say, 2 inches by 2½ inches section, and proportionally smaller quantities as the tool grows smaller.

For economy, the same water should be used over and over again, and it should be supersaturated with soda to prevent the machines from rusting. Wrought iron pipes about 1¼ inch diameter should lead the water from beneath the machine below the floor to the main soda water drains at the side of the shop. These drains are made of pipe from 3½ to 5 inches in diameter, with a chain extending through them

* Abstract of paper read before the American Society of Mechanical Engineers, December, 1906.

from one end to the other, the chain being twice as long as the drain through which it extends. In case of sediment forming in this pipe, or in case of chips passing by the double sets of screens and double settling pots which should be supplied at each machine, the drain can be quickly cleaned by pulling the chain once or twice backward and forward through it.

The soda water is returned through this system of underground piping to a large central underground tank, from which it is pumped through a small, positive, continuously running pump, driven by the main line of shafting, into an overhead tank with overflow which keeps the overhead soda water supply mains continually filled and under a uniform head. If the shop is constructed with a concrete floor, a catch basin for the water can be molded in the concrete, directly beneath each machine. Otherwise, each machine should be set in a large wrought iron pan or shallow receptacle which catches the soda water and the chips. In both cases, however, two successive settling pots—independently screened so as to prevent the chips, as far as possible, from getting into the return main—are required beneath each machine.

The ends of the 1¼-inch wrought iron pipes which lead the water from the machines to a large drain at the side of the shop should be curved up with a sweeping curve so that their outer ends come close to the top of the floor of the shop. The sediment and chips must be cleaned from these pipes from time to time by means of a long round steel rod from ⅜ to ½ inch in diameter, which, after removing the plug at the outer end of the drain pipes, is shoved through the pipe. Apparatus of this type has been in successful use for about 23 years with no trouble from clogging.

Chatter of the Tool.

The following are the general conclusions arrived at on the subject of chatter of the tool:

A. Chatter is the most obscure and delicate of all problems facing the machinist, and in the case of castings and forgings of miscellaneous shapes probably no rules or formulas can be devised which will accurately guide the machinist in taking the maximum cuts and speeds possible without producing chatter.

B. It is economical to use a steady-rest in turning any piece of cylindrical work whose length is more than twelve times its diameter.

C. Too small lathe-dogs or clamps, or an imperfect bearing at the points at which the clamps are driven by face-plate, produce vibration.

D. To avoid chatter, tools should have cutting edges with curved outlines, and the radius of curvature of the cutting edge should be small in proportion as the work to be operated on is small. The reason for this is that the tendency of chatter is much greater when the chip is uniform in thickness throughout, and that tools with curved cutting edges produce chips which vary in thickness, while those with straight cutting edges produce chips uniform in thickness.

E. Chatter can be avoided, even in tools with straight cutting edges, by using two or more tools at the same time in the same machine.

F. The bottom of the tool should have a true, solid bearing on the tool support which should extend forward almost directly beneath the cutting edge.

G. The body of the tool should be greater in depth than its width.

Chatter caused by modifications in the machine may be classified as follows:

H. It is sometimes caused by badly made or fitted gears.

J. Shafts may be too small in diameter or too great in length.

K. Loose fits in the bearings and slides may occasion chatter.

L. In order to absorb vibrations caused by high speeds, machine parts should be massive far beyond the metal required for strength.

The Effect of Chatter upon the Cutting Speed of the Tool.

M. Chatter of the tool necessitates cutting speeds from 10 to 15 per cent slower than those taken without chatter, whether tools are run with or without water.

N. Higher cutting speed can be used with an intermittent cut than with a steady cut.

Of all the difficulties met with by a machinist in cutting metals, the causes for the chatter of the tool are perhaps the most obscure and difficult to ascertain, and in many cases the remedy is only to be found after trying (almost at random) half a dozen expedients. This paper is chiefly concerned with chatter as it is produced or modified by the cutting tool itself. Some of the other causes for chatter, however, may be briefly referred to. These may be divided into five groups:

A. The design of the machine;
B. The nature and proportions of the work being operated upon;
C. The care and adjustment of the parts of the machine;
D. The method of setting the work in the machine or of driving it;
E. The shape of the cutting tools, manner in which they are set in the machine, and the speeds at which they are run.

Causes *A* and *B* are outside the control of the machinist. Elements *C*, *D* and *E* are, or should be, to a large extent under the control of the management of the shop.

A. Referring, now, to cause *A*, "The design of the machine," the chief elements causing chatter in the design of a machine are:

Aa. Gears which are set out of proper adjustment, or the teeth of which are untrue. It should be noted that involute teeth will run smoothly whether their pitch diameters exactly

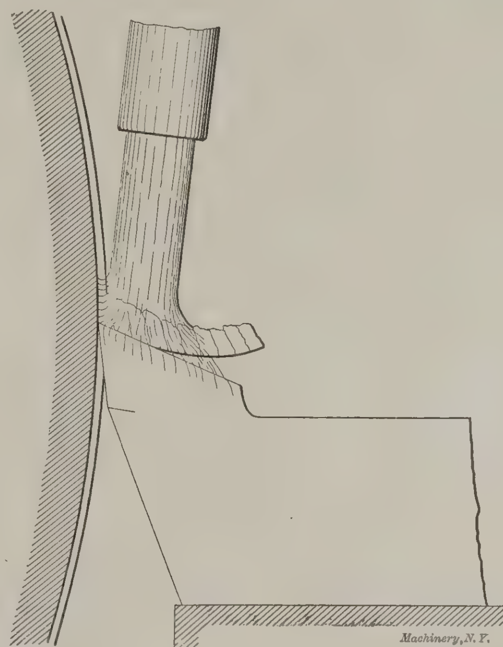


Fig. 47. Method of Throwing Water on Tool, Giving the Best Results.

coincide or not, whereas the epicycloidal teeth are almost sure to rattle unless their pitch lines are maintained in their exact proper relations one to the other.

Ab. Chatter is frequently caused through mounting the driving gears upon shafts which are either too small in diameter or too long. A large excess in the diameter of shafts beyond that required for strength is called for in order to avoid torsional deflection which produces chatter.

Ac. Lathe shafts and spindles must of course be very accurately and closely fitted in their bearings, and the caps adjusted so as to avoid all play.

Ad. For heavy work the lathe tail-stocks should be fastened to the bed plates with bolts of very large diameter, and should be tightened down with long handled wrenches.

Ae. The lathe bed itself should be exceedingly massive, and should contain far more metal than is required for strength, or even to resist ordinary deflections; and the moving tool supports should also be heavy far beyond what is required for strength.

Massive Machines Needed for High Speeds.

Undoubtedly high cutting speeds tend far more than slow speeds toward producing minute and rapid vibrations in all parts of the machine, and these vibrations are best opposed and absorbed by having large masses of metal supporting the cutting tool and the head- and tail-stocks. It is largely for the purpose of avoiding vibration and chatter in machines that the high cutting speeds accompanying the modern high speed tools call for a redesigning of our machine tools. While it is true that in many cases a very great gain can be made by merely speeding up a machine originally designed for slow

speed tools, this increase in speed almost invariably produces a corresponding increase in the vibration or chatter, and for absorbing this, the lathes and machines of older design are, in many cases, too light throughout.

B. Cause *B*, namely, "The nature and proportions of the work being operated upon." In assigning daily tasks to each machinist with the help of our slide rules, the element which still continues to give the greatest trouble to the men who write out these instructions is deciding just how heavy a cut can be taken on the lighter and less rigid classes of work without causing chatter. This branch of the art of cutting metals has received less careful and scientific study than perhaps any other. While the element is one which must always remain more or less under the domain of "rule of thumb," since the causes which produce chatter, particularly in castings of irregular shapes, are so many and complicated as to render improbable their successful reduction to general laws or formulas, undoubtedly much can be done toward attaining a more exact knowledge of this subject, and experiments in this line present a most important field of investigation.

The following rule (belonging to the order of "rule of thumb") which has been adopted by us after much careful and systematic observation, extends over work both large and small, and covers a wide range: *It is economical to use a steady-rest in turning any piece of metal whose length is more than twelve times its diameter.* When the length of a piece becomes greater than twelve times its diameter, it is necessary to reduce the size of the cut to such an extent that more time will be lost through being obliged to use a light cut than is required to properly adjust a steady-rest for supporting the piece.

C. Cause *C* namely, "The care and proper adjustment of the various parts of the machine" is almost entirely under the control of the shop management. It is of course evident that so far as the effect of chatter is concerned, one of the most important causes can be eliminated from the shop by systematically looking after the careful adjustment of all of the working pasts of the machine to see that the caps of the bearings are always so adjusted as to have no lost motion and yet not bind, and so that all gibs and wedges for taking up wear upon the various slides are kept adjusted to a snug fit. It is our experience, however, that the adjustment of the various parts of the machine should in no case be left to the machinist who runs his lathe, but that the adjustment and care of machines should be attended to systematically and at regular intervals by the management. In large shops a repair boss with one or two men can be profitably kept steadily occupied with this work.

D. Cause *D*, namely, "The method of setting the work in the machine or of driving it," is in many cases capable of being directly under the control of the machinist.

Da. One of the most frequent causes for chatter lies either in having too light or too springy clamps or lathe dogs fastened to the work for the purpose of driving it, or in having vibration at the point of contact between the lathe dog and the face-plate of the lathe, or the driving bracket, which is clamped to it. In heavy work the clamps should be driven at two points on opposite sides of the face-plate, and great care should be taken to insure a uniform bearing of the clamps at both of these driving points. Chatter through vibration at this point can frequently be stopped by inserting a piece of leather or thick lead between the clamps and the driving brackets on the face-plate, which has the effect both of deadening the vibration and equalizing the pressure between the two outside diameters at which the clamp is driven by the face-plate.

Db. A dead center badly adjusted so as to be either too tight or too loose on the center of the work, or any lost motion in the tail-stock of the lathe is such an evident source of chatter that it need not be dwelt upon.

E. Cause *E* namely, "The shape of the cutting tools, the manner in which they are set in the machine and the speeds at which they are run." We have attempted to explain the effect of a uniform thickness of chip in causing chatter, and have indicated that the proper remedy for this is to use a round-nosed tool, which is always accompanied by a chip of uneven thickness. We have also referred to the desirability of having the body of tools deeper than their width in order to insure strength as well as to diminish the downward deflection of the tool, which frequently results in chatter, particularly when the tools are set with a considerable overhang beyond their bearing in the tool-post. We have also called attention to the great desirability of designing tools with their bottom surfaces extending out almost directly beneath the cutting edge, and of truing up the bottom surface of the tools, so as to have a good bearing directly beneath the nose of the tool on the tool support. If sufficient care is taken in the smith shop, and the smith is supplied with a proper surface plate, the tools can be dressed so as to be sufficiently true on their bottom surfaces for all ordinary lathe work.

It has been the necessity for avoidance of chatter which has influenced us greatly in the adoption of round-nosed tools as our standard. Tools with straight cutting edges, which remove chips uniform throughout in thickness can be run at very much higher cutting speeds than our standard round-nosed tools; but owing to the danger of chatter from these tools, their use is greatly limited, in fact, almost restricted to those special cases in which chatter is least likely to occur. Attention should be called, however, to a method by which straight edge tools have been used successfully for many years upon work with which there was a very marked tendency to chatter.

While at the works of the Midvale Steel Company we superintended the design of a large lathe for rough turning gun tubes and long steel shafts, in which tools with long, straight cutting edges were used without chatter, and yet at the high speeds corresponding to the thin chips which accompany this type of tool. This lathe was designed with saddle and tool-posts of special construction, so that two independently adjustable tool supports were mounted on the front side of the lathe and one on the back side. In each of these slides a heavy straight-edge tool was clamped. The three tools were then adjusted so that they all three removed layers of metal of about equal thickness from the forging, and, although the tendency toward chatter owing to the uniform thickness of the chip was doubtless as great with these straight-edge tools as with any others, the period of maximum or of minimum pressure for all three tools never corresponded or synchronized so that when one tool was under maximum pressure, one of the others was likely to be under minimum pressure. For this reason the total pressure of the chips on all three tools remained approximately uniform and chatter from this cause was avoided.

There is one cause for chatter which would seem to be impossible to foresee and to guard against in advance, *i.e.*, chatter which is produced by a combination of two or more of the several elements likely to cause chatter. If, for instance, the natural periods for vibration in the tool and in the work or in any of the parts of the lathe and the work happen to coincide or synchronize, then chatter is almost sure to follow; and the only remedy for this form of chatter seems to lie in a complete change of cutting conditions; a change, for instance, to a coarser feed with an accompanying slower cutting speed, or *vice versa*. Unfortunately, for economy, higher speeds rather than slow speeds tend to produce this type of chatter, and the remedy therefore generally involves a slower cutting speed.

Higher Cutting Speed Can be used with an Intermittent Cut than with a Steady Cut.

An intermittent cut has a very different effect upon cutting speed from that produced by chatter. We have observed in a large number of cases that when a tool is used in cutting steel with a heavy stream of water on it (and this is the proper method of cutting steel of all qualities), a rather higher cutting speed can be used with an intermittent cut than with a steady one. The reason for this is that during that portion of the time when the tool is not cutting, the water runs directly on those portions of the lip surface and cutting edge of the tool which do the work, and for this reason the tool is more effectively cooled with intermittent work than with steady work. As an example of intermittent work, the writer would cite:

a. Cutting the outside diameter of a steel gear-wheel casting, in which case the tool is only one-half its time under cut;

b. Or turning small pieces of metal which are greatly eccentric;

c. Or, for example, all planer and shaper work which is not too long.

It would seem from a theoretical standpoint that a tool would be greatly damaged (and therefore a slow cutting speed would be called for) by the constant series of blows which its cutting edge receives through intermittent work. It will be remembered, however, that in planer work (and this class of intermittent work comes to the direct attention of every machinist), the tool is more frequently injured while dragging backward on the reverse stroke of the planer than it is while cutting, and it is very seldom that a tool is damaged as it starts to cut on its forward stroke. *In all cases, however, where the tool deflects very greatly, when it starts its cut on intermittent work, slower speeds are called for than would be required for steady work.*

The above remarks on intermittent work do not, of course, apply to cast iron with a hard scale, or the surface of which is gritty. It is evident that in all such cases, owing to the abrasive action of the sand or scale on the tool, intermittent work is much more severe upon the tool than a steady cut.

* * *

TABLES OF DIMENSIONS FOR HUNG BOILERS.

G. L. PREACHER.*

Since the publication of the table of dimensions for hung boilers, which appeared as supplement to the December, 1905, issue of MACHINERY, the writer has received from time to time a number of inquiries from some of those interested in settings of return tubular boilers. These inquiries have been varied, but in all instances the questions asked were relative to installations of more than one boiler in the same setting. As the table above referred to only contains data for single settings (one boiler), a table has been compiled (see Supplement) giving the data necessary for several boilers, so that by the use of the two combined, one would have before him all necessary data for installing any number of boilers.

In ordinary practice, not more than three boilers are ever suspended from a single span of beams, and the table therefore has been worked up for one, two and three boilers. In cases of four boilers, extra columns are generally placed between the two middle boilers, thus making two separate spans of two boilers each. In cases of five boilers, columns are generally placed between the second and third boilers, making two spans of two and three boilers respectively, or additional columns are placed between the fourth and fifth boilers, making three spans of two, two and one boilers respectively. In some instances columns are placed between all the boilers, thus putting only one boiler to a span of beams. Calculations will show this latter arrangement to be the cheapest, for the reason that lighter columns and beams can be used.

In presenting this table the writer wishes to call attention to values calculated under headings: "Total Weight of Boilers and Fixtures," and "Total Weight of Water." It can be readily understood that these values, although based somewhat on experience, are only arbitrary and would vary according to conditions. For instance, a 150 horsepower low-pressure boiler would weigh less than a similar one for high-pressure. The weight of water in the boilers would also depend upon the number and size of tubes and braces occupying the water space. In calculating, therefore, the size beams, columns and hanger bolts for supporting the different size boilers, weights must be determined that will cover all conditions. The values given will be sufficient to calculate from, and although they may seem excessive in some instances, they embody good practice, and the use of smaller ones is not advisable.

* * *

The attendance at the ten highest institutions for technical education in Germany during the winter season 1906-1907 was 15,453, the highest number coming on the Institute of Berlin, where there were 2,375 regular engineering students, besides 754 special students who only took part of special courses.

* Address: Lombard Iron Works and Supply Co., Augusta, Ga.

SPRING MEETING OF THE A. S. M. E.

The spring meeting of the American Society of Mechanical Engineers was held at the Hotel Claypool, Indianapolis, Indiana, May 28 to 31 inclusive. About 300 persons, including members and guests, were registered. The meeting was enlivened by the Decoration Day exercises, when a bronze statue of General Lawton was unveiled by President Roosevelt. The plants of the Atlas Machine Co., National Motor Vehicle Co., Nordyke & Marmon, Parry Mfg. Co., etc., were open to visitors. The principal visiting event of the week, however, was the visit to Purdue University, on Friday. Special interurban cars were provided for carrying the members and guests to the University over the Indianapolis & Northwestern electric line, connecting Lafayette and Indianapolis. The closing session was held in one of the University buildings. Announcement was made of the election of Andrew Carnegie as honorary member of the society, and of the adoption of two amendments to the constitution. The report by Mr. F. J. Miller stated that the joint obligation of the A. S. M. E. in the land debt is about $200,000, of which $80,000 was paid by the net proceeds from the sale of the old society house at 12 West 31st Street, and $70,000 by subscription, leaving a debt of $50,000 still to be raised. Inasmuch as the annual election of officers takes place just prior to the December meeting, there are no official changes made at the spring meeting.

PARTIAL SYNOPSIS OF PAPERS.

Standard Proportions for Machine Screws.

The committee having this matter in charge presented an amended report, following the suggestions that have been made since the original report was presented at the New York meeting in December, 1905. (See MACHINERY, June, 1906, for abstract.) It has been found advisable to change, except in three instances, the nominal outside diameters for standard sizes of machine screws, and to include in the new list certain additional sizes. The change in the sizes originally proposed vary only from 0.001 to 0.003 inch. The standard diameters adopted are 21 sizes. The pitches are a function of the diameter, and are expressed by the formula:

$$\text{Threads per inch} = \frac{6.5}{D + 0.02}$$

The results are used approximately and in even numbers to avoid fractional or odd numbers of threads. The amended report was adopted.

Pressures of Lap-welded Steel Tubes. By Prof. Reid T. Stewart.

This paper is a supplement to the extensive paper presented by the author at the June, 1906, meeting of the A. S. M. E. While testing the 10-inch tubes, the conditions were found to be such that with the apparatus in use it was practicable to make a series of re-tests on each of these tubes. It was found that the formula,

$$P_2 = 0.0926 \frac{P_1 - 47.55}{M - 0.874} + 47.55$$

in which,

P_1 = collapsing pressure of normally round tube,

P_2 = collapsing pressure of distorted tube,

M = maximum divided by minimum outside diameters,

is strictly applicable, for the kind of distortion to which it applies, to 10-inch Bessemer steel tubes, 0.15 to 0.20 thickness wall.

Balancing of Pumping Engines. By Mr. A. F. Nagle.

The paper by Mr. Nagle is an account of an investigation as to the proper weight of the plunger of a vertical triple expansion crank and fly-wheel pumping engine. The author concludes that there is no reason why fly-wheels in triple expansion pumping engines should be so very heavy. The turning moments during one revolution do not vary 16 per cent, and an absolute uniform rotative velocity of the wheels is not necessary. With plungers weighted as described in the paper, the author believes that many examples exist where the weight of the fly-wheels of pumping engines could be safely reduced one-half.

Superheated Steam in an Injector. By Mr. Strickland L. Kneass.

In view of the growing use of superheated steam, it was deemed timely to present a few notes on the use of superheated

steam in the injector. Since the injector is a condensing apparatus, it follows that a condition of the steam which retards condensation reduces its efficient mechanical action. Hence the use of superheated steam in injectors is not advisable. It is essential that the condition of the steam permit instant and complete condensation, and that its velocity reach a maximum at the instant of impact with the water. The practical effect of superheated steam on the action of an injector is to reduce the maximum capacity, increase the minimum capacity, and to lower the limiting temperature of the water supply with which the injector can operate. With high pressure and superheat an efficiently designed instrument is likely to become inoperative. Therefore, in all superheated steam plants using injectors for boiler feeders, it is desirable that the injector be supplied with saturated steam.

Flow of Superheated Steam in Pipes. By Mr. E. H. Foster.

From investigations carried on in a large number of steam plants the author has collected certain data which indicate that the laws governing the flow of superheated steam differ appreciably from those governing the flow of saturated steam. A high velocity of superheated steam in pipes is recommended, because there is a smaller percentage of heat loss, and because there is a lower actual drop in temperature. The author recommends for steam pipes of straight runs or easy bends a velocity of 6,000 to 8,000 feet per minute where a superheat of 100 to 299 degrees F. is used.

The Performance of Cole Superheaters. By Prof. W. F. M. Goss.

The author describes the Cole superheater as applied to a locomotive in the locomotive testing laboratory of Purdue University. The results of tests show that the degree of superheat in the steam delivered to cylinders is largely affected by the rate of evaporation. It depends upon the smoke-box temperature, which increases with increased evaporation. Thus, when the temperature of the smoke-box is changed from 600 degrees to 800 degrees F., the heat absorbed in superheat rises from 5.6 to 8.5 per cent of the total taken up by the water and steam. A full analysis of cylinder performance is not given in the paper, but the author intimates that the results noted are clearly satisfactory. Locomotive *Schenectady*, under normal conditions of running before the superheater was attached, developed an indicated horse-power on from 24 to 27 pounds of steam. After being equipped with the superheater the same locomotive delivered, under ordinary conditions of running, an indicated horse-power with a consumption of 20 to 22 pounds of superheated steam per hour, the difference being about 17 per cent.

Superheat and Furnace Relations. By Mr. Reginald P. Bolton.

This paper is a plea for a more intelligent study of the relations of steam boiler furnaces and superheating apparatus. Most of the present practise seems to be based on the adaptation of superheating apparatus to standard forms of boilers and settings, and it has become very common practise to install superheating service in some position in the gas passages, without special regard to the conditions that usually obtain. If existing designs of boilers and settings are to be rigidly adhered to, it would seem that the eventual aim should be in the direction of remodeling designs of both boiler and setting in favor of superheating apparatus. Merely to place a superheating coil in a certain part of the gas passage of a boiler and connect the steam supply to it is by no means to be regarded as a complete solution of the problem. The problem is one in which the designer and manufacturer of every type of boiler is interested, and is one which they cannot be too strongly urged to take in hand.

Air-cooling of Automobile Engines. By Mr. John Wilkinson.

Air-cooled cylinders of automobile engines are likely to become too hot for proper operation. Overheating shows itself in a number of ways. The cylinder may become so hot that the incoming gases expand so much that there is a reduction of power, or the lubricating oil may fail to perform its proper function, causing a great increase of friction, which still further heats the cylinder and reduces its power. The cylinder walls may become so heated that the charge is ignited prematurely. This condition is indicated by energetic knocking. The author points out that the design of cylinders should be such as to reduce to a minimum the amount of heat that is allowed to enter the cylinder walls. For this reason cylinders should not be built with valve pockets on each side of the cylinder, but rather should be made with semi-spherical cylinder heads. For example, the internal surface exposed to heat at the time of expansion in a 4 x 4-inch motor with a semi-spherical cylinder pocket is about 38 square inches; the same size motor with valve pockets on the sides of the cylinder exposes about 74 square inches to the exploded gases. It is self-evident that the loss must be much greater in the latter case. Engines with a semi-spherical head will show a gain of from 25 per cent in power and efficiency over the prevalent type with valve pockets on each side. This type of cylinder head may be machined smooth on the inside and thus reduce its absorbent effect to a minimum. The best internal conditions may be summed up as follows:

a. To present the minimum internal surface to the heat.
b. To make this surface as smooth as possible.
c. To carry off the hot exhaust gases at the bottom of the stroke before the main exhaust valve opens.
d. To get rid of remaining gases with as little surface contact with the cylinder as possible.
e. To reduce friction of piston to a minimum.
f. Keep all the projections out of the cylinder.
g. To make the compression fit all conditions.

Materials for Automobiles. By Mr. Elwood Haynes.

This paper is a review of the physical characteristics of nickel steel, nickel-chrome steel, alloy tool steel, vanadium steel, bronze and aluminum. The present requirements of automobiles have greatly improved the quality of steels not obtainable for this and kindred purposes. Bronze is recommended in automobile construction only for parts requiring low rigidity and moderate strength. Aluminum is now used very largely both pure and in alloy form. Alloyed with copper, it has increased hardness and elasticity. Zinc and aluminum form an alloy having considerable rigidity and elasticity and quite high tensile strength. Nickel steel containing from 4 to 5 per cent nickel and less than 0.3 carbon is recommended for rear live axles. Vanadium is recommended for front axles, steering knuckles, propelling shafts, etc. For sliding gears, nickel-chrome steel hardened throughout, or mild nickel steel case-hardened, are recommended. For crank-shafts, use nickel steel or vanadium steel. For frames, use low carbon open-hearth steel, mild nickel steel or nickel-chrome steel. Open-hearth steel of say 0.4 per cent carbon is recommended for hand levers, tubing, and nearly all other parts of a car.

Superheated Steam on Locomotives. By Mr. H. H. Vaughan.

The author reviews the application of superheaters to locomotives in the United States and illustrates Schmidt's superheater, the type most used in Europe. Mr. Vaughan is assistant to the president of the Canadian Pacific Railway and is responsible for the application of 197 various types of superheaters to the locomotives on that road. The Vaughan-Horsey type of superheater is described, of which 88 are in use on the Canadian Pacific, and of which 175 more are ordered. The paper concludes that the locomotive superheater is worth while. Although there have been troubles from lubrication and leakages, the added capacity of a locomotive and the reduction of the work required of the fireman, to say nothing of the saving of fuel and repairs, make the superheater a boiler feature that considerably decreases the cost of locomotive operation and maintenance.

Special Auto Steel. By Mr. Thomas J. Fay.

The paper is descriptive of the characteristics of high-grade alloy steels that have been developed within the past few years, and which are especially adapted to the severe requirements of automobile construction. The paper is illustrated with photographs showing specimens of bent forgings, chips taken from chrome-nickel steel, etc.

Ball Bearings. By Mr. Henry Hess.

This paper for the most part consists of a *resumé* and translation of Prof. Stribeck's report on his investigations on bearings made at the Central Laboratory for Scientific Investigation at Neubabelsberg near Berlin, Germany. An abstract will be published later.

A NEW PROCESS OF MAKING WELDLESS CHAINS.

The weldless chain, in the form of the common plumber's or "safety" chain, is a familiar article. It is said to have been devised originally by the inventor of the first watchman's time detector, as the means of fastening the various keys used in the system, scattered at different points about the premises. A chain of this sort can only be "unraveled" from one end, and if that end is sealed with the image and superscription of the owner, the task of deception is a difficult one.

Iron chains of large sizes have been made on the same principle, but more for reasons of strength and ease of making, than for safety. It is a point gained when the weld of the

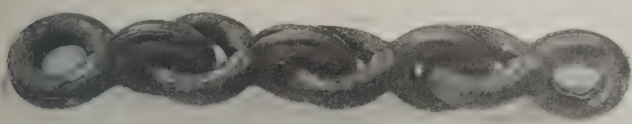


Fig. 1. Weldless Chain, Involving a New Principle of Construction.

ordinary chain link is avoided, since its strength can never be prophesied beforehand, and the whole chain, in the words of the common proverb, is "no stronger than its weakest link." As such chains have hitherto been made, however, it has always been necessary to make the opening in the outer link long enough to admit the next link to be added to the chain. While this elongated link does very well on sheet metal plumber's chain, it is a source of weakness in chains of wrought iron or steel, of large sizes, intended to support great loads. When such a chain passes over a sheave or around a sprocket, the bending stresses set up in the long links quickly deform them and spoil the chain. The object of the invention of an Hungarian, Stefan Kiss v. Ecseghy, by name, is to make it possible to produce chains of this kind with very short, stiff links.

The shape of the chain is shown in Fig. 1. As will be seen, each link is double, being formed of two loops at right angles to each other, one of the loops being split. The method of forming the chain is shown in Fig. 2. The secret of the

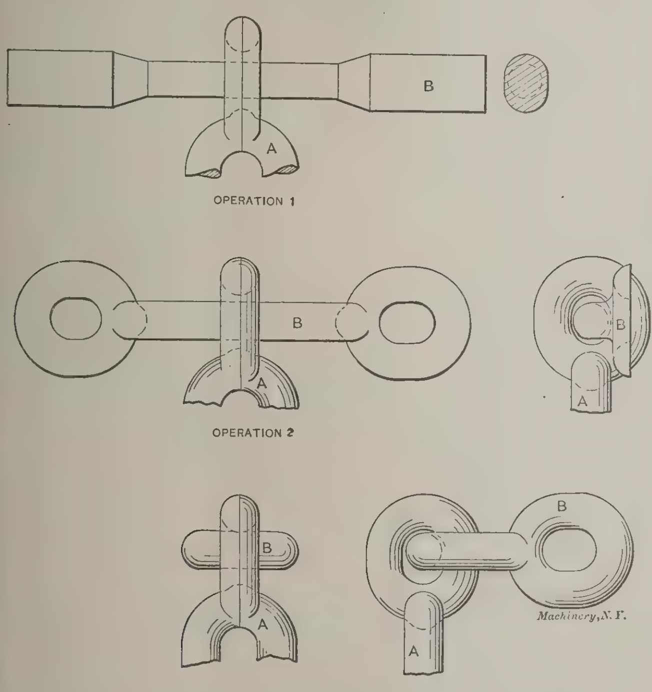


Fig. 2. The Operations followed in Making the Weldless Chain.

process is shown in the first operation. *A* is a completed link, and *B* the blank from which a new link is to be formed. As will be seen, this is made of stock somewhat larger than the size of the chain, reduced in its central portion to that size. These blanks may be made by drop-forging, rolling or any other commercially suitable method. One of them is heated in the forge and inserted in the end of the already completed portion of the chain, as shown. The ends are then struck up under dies to the shape shown in operation 2, where *A* is the end of the finished chain, and *B* the new link being formed. It will be seen that the hole in the old link is but slightly larger than the diameter of the stock composing the new one, while the new half links in the end are of considerably greater size. It would evidently be impossible to insert them if they were formed before insertion, hence the process of inserting the blank first and forming it afterwards. This is the vital principle of the patent. As shown in the third operation, the ends of *B* are next bent around to form the now completed link, which is thus made ready for the insertion of the next blank, as in operation 1.

Fig. 3 shows the machine and dies used for doing this work. The press shown is of a type common in Europe, though seldom, if ever, seen in this country. The two friction wheels on the horizontal driving shaft may either of them be shifted to engage the rim of the heavy balance wheel attached to the vertical screw. The screw raises and lowers the ram of the press. The operator controls the friction wheels by the handle shown, or by the treadle at the base of the machine. A stop

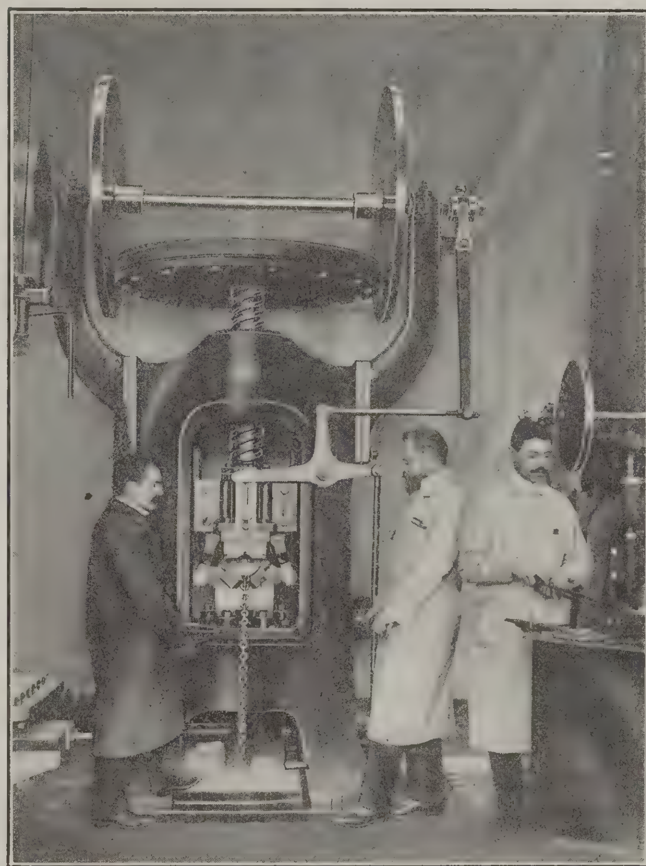


Fig. 3. Press Used in Making the Chain, with the Dies in Place.

on the ram automatically throws out the disk controlling the elevating motion, and stops the ram at the upper limit.

The dies used in this press are shown in Fig. 4. With this arrangement, three operations are necessary for the forming of the completed link, these operations corresponding to those shown in Fig. 2. The completed portion of the chain is suspended over a pulley from the ceiling with the free end in easy reach of the operator of the machine. A heated blank of the shape shown in Fig. 2, operation 1, is taken from the forge, inserted through the link, and placed in dies *C C* on the bed of the press. Ram *D*, shown best in the small detail at the lower left-hand corner, is then brought down on the link, flattening out the ends and curving the central portion. The plunger is raised again, the link is moved forward to dies *E E*, and the plunger is again brought down. The die at *E* is compound, and punch *F* above it, descending on the work, forms the rounded half links on the end of the blank, punches the hole, and trims off the periphery of the work.

The ram of the press is raised for a third time, and the now completely formed (but still open) link is moved to the bending dies at *G G*. When the ram of the press is brought down on the work at this point, after smoothing the work under the

pressing action of punch *H*, pins *J J* are pushed in by the operator, entering holes in the links *R R*, which are then in position to receive them. Of the two parts *G*, the one at the left in the left-hand view is fastened to a holder integral with ring *K*, while the other one is supported in a similar manner from ring *L*. These two rings are free to rock about each other and about the pivot *M*, formed in the bracket casting *N*, attached to the bed of the machine. A tie-bar *O*, keyed to the base *P*, serves to support the over-hanging pivot *M* of bracket *N*. A support not shown in the cut extends out over the finished portion of the chain through which the new link passes, and supports it against the upward pressure of the bending operation, which now takes place. When the ram of the press is started upward, links *R* attached to it, draw after them die holders *Q Q*, which rock as described about the axis of pivot *M*. By this means the link is bent finally into its complete form, as shown in operation 3 of Fig. 2.

machine, where first the central hole was punched through, after which, for a completing operation, the link was pushed through a trimming die to have the fin shaved off. This resulted in an exceedingly neat and clean-looking link with the joint tightly closed and smoothly finished. The operation of forming a link for a half-inch chain takes 25 seconds.

Besides the obvious rapidity of making chains by this method, there is the more important advantage of greatly increased strength. The British government requirements for chains insist on a factor of safety of 5, owing to the unknown quantity of the strength of the weld. A good welded half-inch chain fails at about 13,000 pounds. Samples of this improved weldless type test at about 16,000 pounds when made of wrought iron, and they run with remarkable uniformity at about this load, showing that a higher factor of safety could easily be used. Furthermore, the use of steel is made possible by the fact that a welding heat is not required. A heat intense

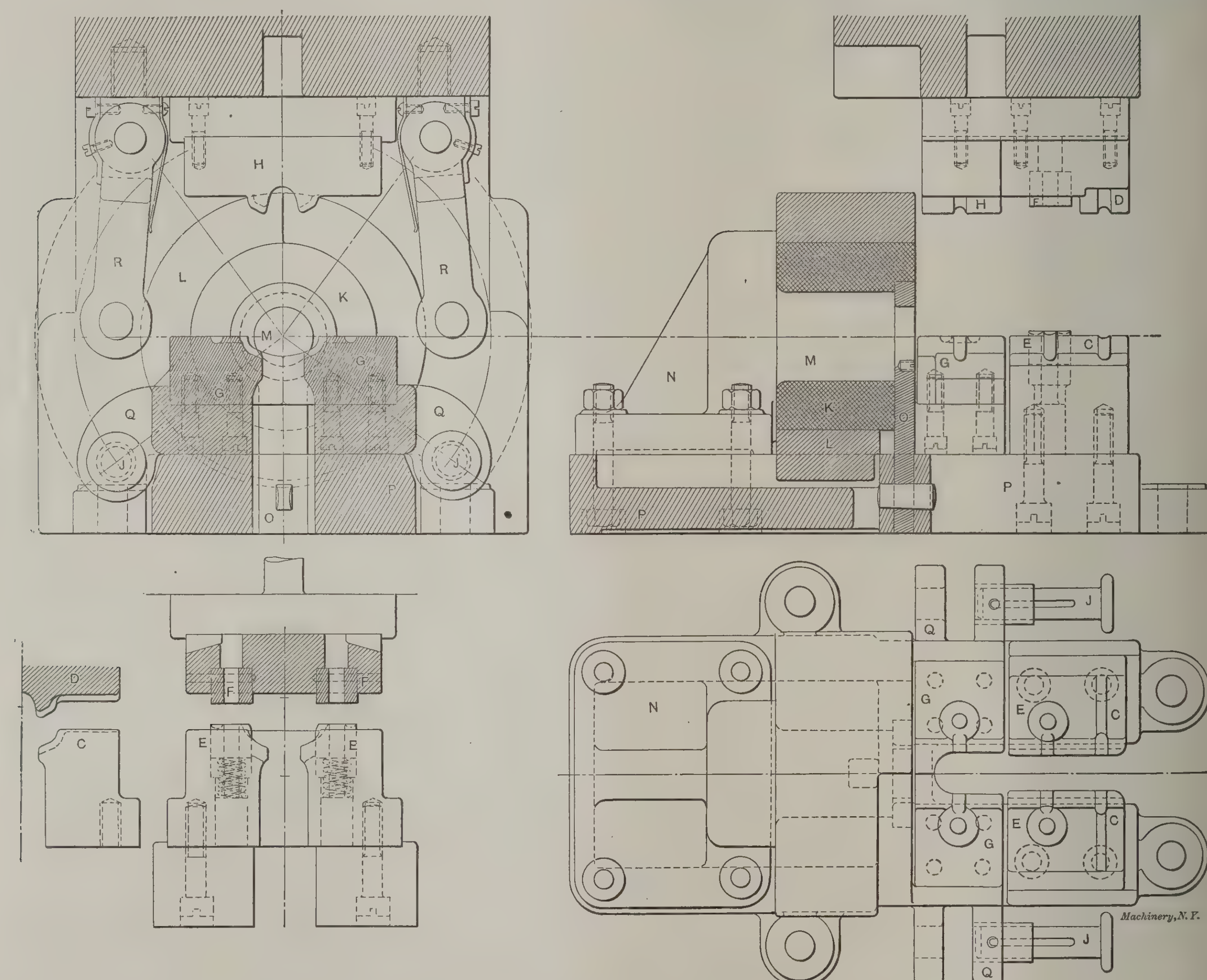


Fig. 4 Tools used in the Press shown in Fig. 3.

The half-tone, Fig. 3, shows three operators. This is not necessary, however, as one of the men there shown is there merely, probably, for the sake of having his picture taken. A boy to tend the fire, and a smith to work the press, is all that is required. The machine is started and stopped by the treadle. The man at the extreme left is the inventor.

The writer has had an opportunity of seeing this process in operation. The tools used were somewhat different from those shown, and more operations were required, although the basic principle involved in the invention was identical. The new link of the chain, which was of half-inch size, was bent in die *C* as described, but in die *E* the ends were merely rounded, and the central hole formed nearly through, without being actually punched. The new link was then closed up in a third operation as before. These operations took place in a press of the same type as shown in Fig. 3. The unfinished link was next taken to a small crank press standing beside the larger

enough to weld steel will decarbonize it, so that it has not the strength that it previously possessed. Steel is especially useful in crane service, where durability is fully as important as strength. A wrought iron chain will wear and stretch until it will not fit the sprockets, long before it breaks. Steel chains made by this new process test at about 21,000 pounds for ½-inch size. Fractured samples seen by the writer failed at the sides of the links, and not, as might be expected, at the joint where the two parts of the same link come together. An interesting point was the fact that the two halves of the split link begin to separate a little time before the final rupture takes place, thus serving as a sort of safety indicator to apprise the user of the fact that he is near the danger limit.

This invention is controlled by the Internationale Handelsgesellschaft, Kleinberg & Co., and is for sale in this country by the International Import and Export Co. of No. 1 Madison Ave., New York.

LETTERS UPON PRACTICAL SUBJECTS.

DEVICE FOR LAYING OUT THE CAMS OF A CAM PRESS.

The cams which actuate the cutting or drawing slide of a double acting cam press are different from other cams, inasmuch as each one actuates two rollers which are a certain fixed distance apart from each other. In order to avoid backlash or springing of the connecting-rods, a fault which is to be found in most cam presses, it is evident that the rollers must both touch the face of the cam at all times. In Fig. 1

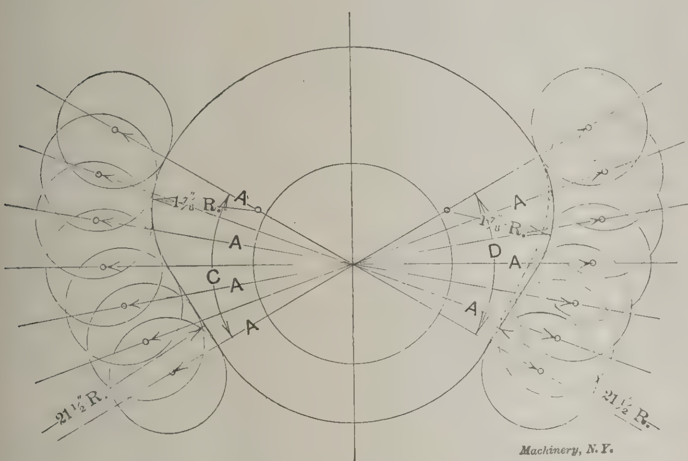


Fig. 1. Ordinary Method of Laying Out Cams.

is shown the ordinary method of laying out such cams; this cut also shows the fact that this ordinary method does not accomplish the end desired. We see that in this cam both curves which give to the slide its up and down motion are constructed with the same radii, which clearly must give a curve that is faulty at certain points. The one main feature that our cam must possess can be expressed as follows: Two rollers of equal diameters, which are a certain fixed distance (*A* in Fig. 1) apart, on a line passing through center of cam, must always tangent the cam while the cam makes its revolution. Turning to Fig. 1., we see that the curve which spans angle *C* and the dotted curve which spans angle *D* accomplish this object. A little reflection will convince that such a curve

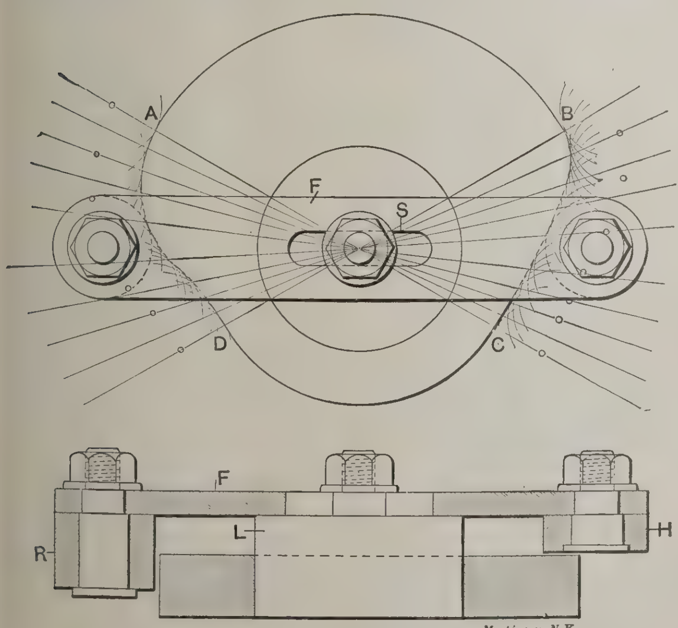


Fig. 2. Device for Laying Out Cams Correctly.

cannot be constructed absolutely correct by giving the radii for both the up stroke and down stroke curve, owing to the fact that the shape of one is entirely dependent on the shape of the other.

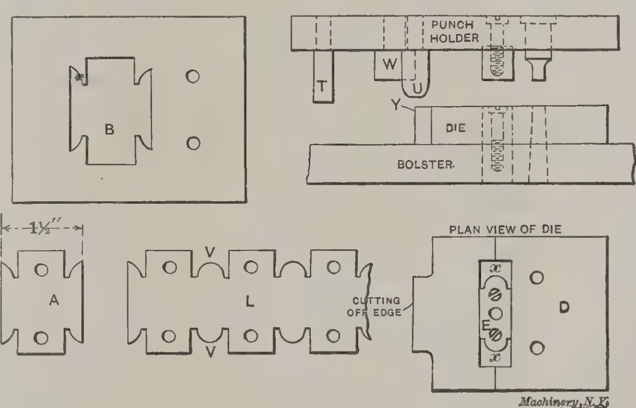
We can, however, give the radii for one curve and construct the other curve from it by aid of the following device. It is assumed that in most cases it will be economical to cut a master-cam, and use this for cutting the others. However, where only a few cams are to be cut, it will be well to construct one with the aid of our device, and use this one as a templet for the others. Fig. 2 shows the device mentioned. First, cut the two arcs, *A B* and *D C*, which of course are perfect circular arcs of given radii, and also cut the curve *A D* from given radii. Then place center plug *L* into center hole of cam and fasten bar *F* onto *L*. Bar *F* has two rollers, *R* and *H*, fastened in such a way that their center distance is equal to the center distance of the cam rollers in the cam press in which the cams are to be used. The rollers *R* and *H* have the same diameter as the cam rollers in the press. We now keep the roller *R* against the cam along the curve *A D* and follow this curve along its entire length. Center plug *L* will always keep the line connecting *R* and *H* in the center of the cam, and slot *S* enables us to follow the curvature of *A D*. By scratching the outline of roller *H* on the cam blank at very short distances apart, we will have a full outline on the cam blank, which must indicate the absolute curvature of *B C*. This curvature must possess all the qualifications set forth above as absolutely indispensable for a correct cam press cam. A cam or set of cams laid out in this manner will silence one of the principal objections usually raised against a cam press: back lash or springing of the cam roller connecting-rods; and practical demonstration has proven the utility of the device shown.

E. E. Eisenwinter.

Providence, R. I.

SECTIONAL BLANKING DIE.

The writer recently had occasion to design a die for cheaply producing the blank shown at *A*. Ordinarily the die is made same as at *B*, involving considerable filing, and causing weak



Built-up Blanking Die.

points on the punch, and weaker ones in the die. The die in question, however, was laid out as shown at *D*, and made in halves to facilitate machining the slot. The part *E* was then made, and securely screwed and doweled to the bolster in its proper position, as shown. Considerable filing on the die, and milling and fitting on punch, was saved by making the die in this way. The chief item in the long run, a great saving of stock, is also afforded. In making the bolster, only the holes x were cut through, leaving a center piece on which to screw piece *E*. The stripper is made with a gage side, and a spring slide on the other side, which keeps the stock against the gage side. To produce the blank *A*, the stock is first carefully stripped to exact width. One end is then fed under the stripper until the end reaches the center of opening x, when the first cut is taken. This operation cuts out the two openings *V* and also pierces the two holes. The stock is then fed along until the end touches the stop pin *T*, and the treadle can then be held down until the end of the strip is reached. The stop pin does not raise above the face of the die, and therefore it is impossible to "jump" the stop. At each stroke the locating pins *U* enter the slots *V* before the punches touch the stock. This locates the stock, and the punch *W* cuts off the piece at *Y*, completing the blank. On thick stock it would be advisable to back up the punch to

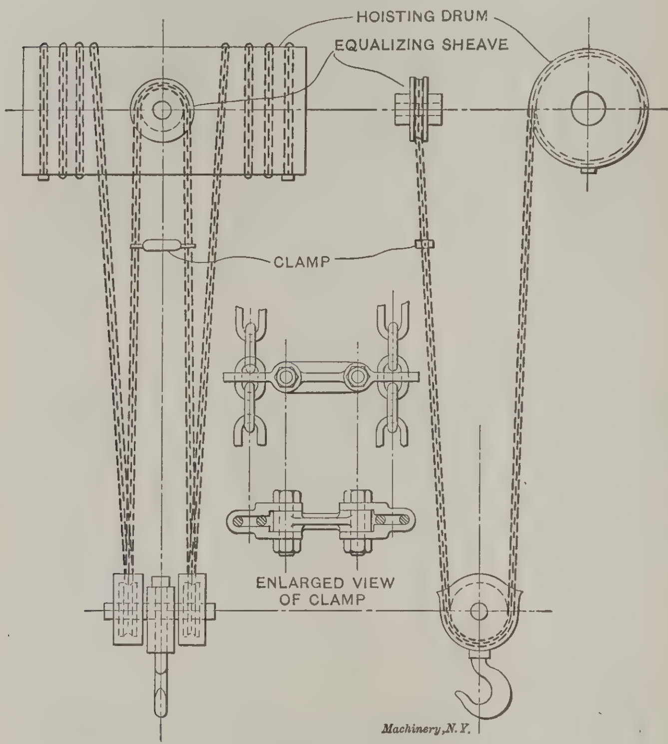
prevent it from springing away on account of cutting only on one edge.

This style of die can be employed on a variety of work where a few thousandths variations are allowable. About the only variation in size that will occur is due to carelessness in cutting stock to exact width. When using a die made as the one shown at B, which leaves a margin of scrap stock on all sides of the space blanked, the loss is between 30 to 50 per cent. The saving of the stock when using the die herein described is a big item. At L is shown a strip of stock as it would look if the pieces were not cut off. F. E. SHAILOR.

Great Barrington, Mass.

EQUALIZING CHAIN CLAMP.

A diagram of the hoisting arrangement of a five-ton crane is shown in the accompanying cut. As will be seen, the two ends of the chain are fastened to the hoisting drum and run down through the hook block sheaves, and then up and around



Chain Clamp.

the equalizing sheave located in the frame in line with the drum. By this arrangement the chain can slip forth and back through the equalizer so as to keep the strain distributed equally on all the four strands of the chain. There was, however, when the crane first was put in place, no provision to keep the chain from getting twisted, and even when the best crane chain was used, it got twisted and would suddenly bind in the hook block, throwing the entire strain on one strand of the chain with the result that the chain would break, causing delay and loss. In order to remedy this and reduce the constant loss from breakage as much as possible, the clamp shown in the cut in enlarged scale was made and put on the chain at the place shown. When put on, the links were turned right from the drum down through the hook blocks and up to about three feet below the equalizer, where the clamp was fastened. This clamp has proven an effective means for preventing the chain from getting twisted. It was the usual thing that we had a broken chain every week or two, while since putting on the clamp we have not had a break for nearly two months.

Valley Park, Mo. W. O. RENKIN.

ADVANTAGES OF STEADY WORKING.

When I was coming home in the car the other night two men sat in front of me discussing the question of more pay; or, rather, they were not discussing it, for they argued that it was impossible to get wages raised as they ought to be. While they were talking, a third man came along and sat opposite them. He was a man whom I know as a shop superintendent, who has risen very rapidly of late years from the ranks, through the grades of gang boss, foreman, salesman, and draftsman, to his present position as superintendent. They repeated, for his benefit, the tale of woe that I had previously overheard. He laughed at them, and then told his story. What he said, I believe he meant, and it seems to me as if it might well be repeated.

"Now, look here, fellows," he said, "you and I worked over at Jones's eight years ago at the scratcher's bench, and I know just as well as if you told me that you have said a thousand times since, when you looked my way, 'A fool for luck.' But I don't see a bit of luck about it. It was hard work there at Jones's, and you fellows laid back when the boss was out of sight and laughed at me for keeping my hammer going. One day the old man lost the man on the chucking lathe, and he sent me up there to fill in until he could get another. Why did he pick me instead of you? Simply because I was there when he came down, and you two chaps were soldiering down in the wash-room. Why did I stick on the chucking lathe? Because I had kept an eye out for what was going on all around the shop, in hopes that when I got a show, I would make good. Then you men laughed at me for not kicking for more pay as quick as I knew I could stay on the machine. But I did not; not then; not until Tom went over to Atkin's shop to work. Atkins asked Tom where he could get a hand to run that old pulley lathe, and Tom told him I could do it. Atkins offered me just the same pay I was getting to go over there and be a machinist. I told the old man about it, and he told me that if I wanted to be a machinist, I should stay right where I was. I suggested that money would talk loud enough for me to hear it, and he raised me a quarter on the spot. And that has been the way ever since. Instead of getting sore and laying back and killing time, I have worked faithfully and steadily, and somehow or other people have heard of it and have invited me to come and work for them. Two or three times I have accepted the offers, but after a time I drifted back home. Now you needn't make up a face and say that no one ever sees you when you are working. They hear of you. Every foreman in the city is looking for men that can do good work and do it quick, and if your heads stood up just a bit above the level of that crowd that you associate with, you would have a better job, even if they had to kidnap you to get you——"

They got off the car there, and I stayed on, but I had heard enough to make me feel that if I had stuck to business better, and kept an eye out for better chances, perhaps I, too, would be better fixed than I am now. CON WISE

THREAD-ROLLING DIES FOR SMALL INTERCHANGEABLE SCREWS.

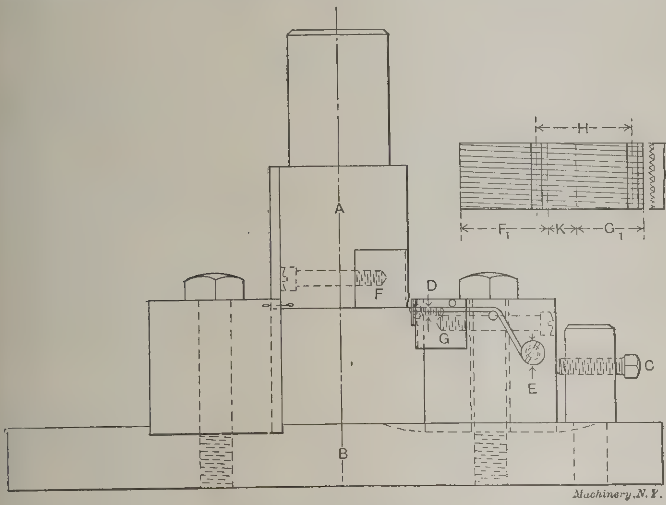
Stacy Oliver.*

The accompanying illustration shows a thread-rolling device as applied to a punch press. A is a punch holder to fit the punch press. B is the bolster, or a piece of cast iron about 1 inch thick, upon which are located two cast iron blocks, one made stationary and the other adjustable by slotting B, so that the block can be forced ahead by the setscrew C. There is a groove in the stationary block and a tongue in the punch holder A to prevent the dies from getting out of line. The screw D is for holding a thin piece of steel as a stop so that the thread can be cut to the desired length. The screw E holds a wire supporting the piece to be threaded until the upper die, F, comes down and carries it past the lower die, G. In cutting the die, it may be made in one piece, H being the

* STACY OLIVER was born in Farmington, Maine, in 1876. He served an apprenticeship in the shops of the Manufacturing Investment Co., Madison, Maine. Among other shops, Mr. Oliver has been working at the Bath Iron Works, Bath, Maine; American Optical Co., Southbridge, Mass.; Stanley Instrument Co., Great Barrington, Mass.; and the Remington Typewriter Co., Ilion, N. Y. He has been employed as machinist, toolmaker, foreman and designer. His specialty is small interchangeable work and the design and making of tools for this class of manufacture.

circumference of the thread to be rolled and G_1 the desired length for the lower die. F_1 is the desired length for the upper die, which must be longer than the lower die so that it will roll the wire past the die G and permit it to drop out of the way. The part K must be cut out when cutting in two parts. The proper angle to which to cut the die depends on the pitch of the thread. The pitch divided by the circumference of the screw to be rolled will give the tangent of the angle. In cutting the die, which must be of good tool steel and hardened after making, the shaper is used. The cut is taken with a tool that can be taken off and put back again without changing its location, such a tool, for instance, as a circular threading tool. In case the point should happen to get dull, the tool can then be removed for grinding. If the feed screw has not got the desired graduations on it, a brass index plate can be made very quickly, and used on the machine. The brass plate should be of a good size and cut accurately in a milling machine, and a pointer clamped on the shaper. S. OLIVER.

Great Barrington, Mass.

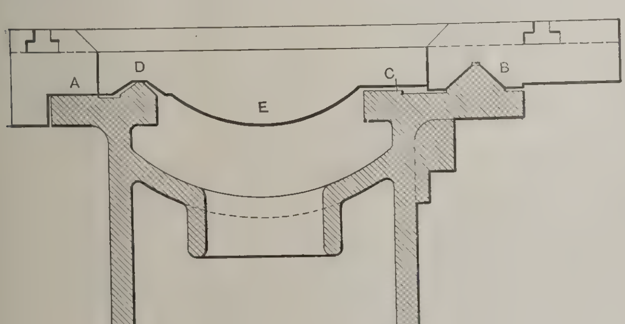


Thread-rolling Device.

SUPPORTING THE LATHE CARRIAGE AT A WEAK POINT.

The accompanying drawing shows a sectional view of the bed of a lathe designed at Michigan Agricultural College. The carriage, with apron removed, is seen resting upon the ways. The bed is of the box form, with openings for the chips to drop through. As will be seen, the carriage slides upon one flat way at A, and on a large V at B. The tail-stock is carried by a flat way at C and one V at D.

As lathe carriages are commonly constructed the bridge or cross-beam is left rough at D, and as the rough casting must have ample clearance, the carriage is weakened at this point. One large machine tool company lowers the V in order to avoid the weakness referred to, and this concern holds a patent on a lathe bed having a "drop-V" for the purpose stated. This circumstance is mentioned to show that the matter is considered as of some importance. In the endeavor to get the same result without infringing a patent, the carriage here illustrated was made wider at the bridge than is commonly done, and was machined at D in such a manner that a slight deflection would cause it to touch the V at this point. This plan is not as good as dropping the V, and doubtless some mechanics will think it is altogether wrong to have a bearing at D. It is somewhat difficult to justify the design, but the idea was to have the carriage scraped to a bearing at both A and D, and then slightly relieved at the latter place. When thus fitted, the carriage touches at D when this support is most needed, *viz.*, when under considerable pressure. It is assumed that the pressure would never be sufficiently great to so deflect the carriage at E as to cause it to lift at A.

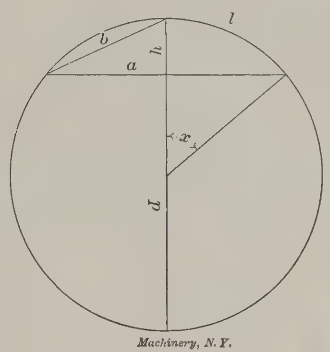


Supporting the Lathe Carriage at a Weak Point.

Atlanta, Ga. W. S. LEONARD.

DIAMETER FROM ARC AND MIDDLE ORDINATE.

In the May, 1907, issue of MACHINERY some formulas were published which I derived at the request of Mr. J. J. Clark, and which were communicated by him to the editor. A brief statement of the method, by which these formulas were obtained, may be of interest.



Diameter from Arc and Middle Ordinate.

Huygens's familiar expression for the approximate length of arc is:

$$l = \frac{8b - a}{3},$$

in which

l = length of arc,

a = length of chord of whole arc,

b = length of chord of half the arc.

Denoting the diameter by d, and the middle ordinate by h, we have, from geometry,

$$a = 2\sqrt{(d-h)\,h}\,;\quad b = \sqrt{d\,h},$$

and Huygens's formula becomes:

$$l = \frac{2\,(4\sqrt{d\,h} - \sqrt{(d-h)\,h})}{3} = \frac{2\sqrt{h}\,(4\sqrt{d} - \sqrt{d-h})}{3}$$

Solving this equation for d, the first of the three formulas communicated by Mr. Clark is obtained. The other two are derived from this by developing the radical and transforming.

When tables are available, the shortest way to solve this problem is as follows: Let $2x$ be the central angle, expressed in radians, corresponding to the arc l. Then,

$$l = d\,x;\; d = \frac{l}{x}.$$

Also,

$$h = \frac{d}{2}(1 - \cos x) = \frac{l}{2x}(1 - \cos x),$$

whence,

$$x + \frac{l}{2h}\cos x = \frac{l}{2h},$$

or, writing c for $\frac{l}{2h}$,

$$x + c\cos x = c.$$

This equation can be very readily solved by trial. The value of x, in radians, is simply the length of the arc, in a circle with a radius = 1, corresponding to the value of x in degrees. Values of x, both in degrees and in radians, can be taken from a table giving lengths of arcs to a radius = 1; the value in radians is substituted in the formula, and the value in degrees is used for computing $\cos x$. If a table of natural versed sines is at hand, the equation may be put in the more convenient form:

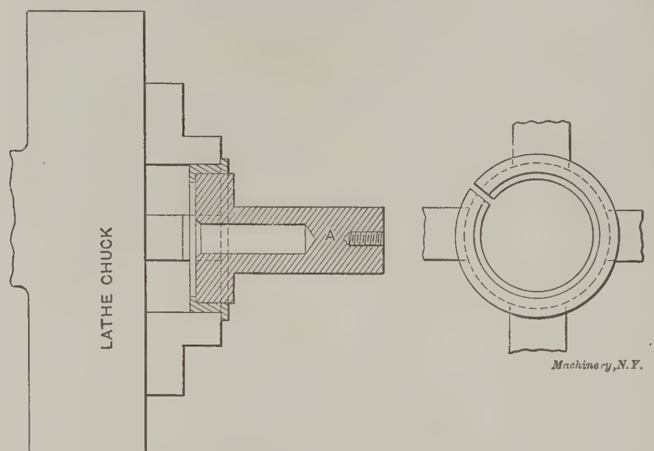
$$x = c \text{ vers } x.$$

I should like to remark, parenthetically, that the practise of using the term "versed sine" to denote the middle ordinate is both obsolete and misleading. The versed sine of an arc or angle is 1 minus the cosine; being a ratio, it is an abstract number, not a linear quantity. ANTONIO LLANO.

Scranton, Pa.

SPLIT BUSHING FOR HOLDING WORK IN LATHE CHUCK.

The cut herewith shows a very useful device for use in a lathe chuck, which I call a chucking ring. It is made of machine steel and is used to hold pieces of 2 inch bar brass, 3 inches long, which are to be turned up as shown at *A*. The bars are too large to be run through the hollow spindle of any lathe in the shop, otherwise the pieces could be turned from the bar. As this is not possible, I cut off all the pieces just long enough to finish to the required length, and then use the ring to hold them during the operation as shown in the cut. The chuck used is a four-jawed independent chuck. The advantages of using this ring are that it holds the work securely, without marring the end, which is left the full size of the bar, and after the first piece is made to run true, by opening and closing the same two jaws each time a piece is removed and another put in its place. I find that they will



Split Bushing for Holding Work in Lathe Chuck.

all come nearly central, without causing much bother of truing up each time. After the first operation has been completed on all the pieces, they are faced and drilled, using a 6-inch universal chuck to hold the piece during the second operation. I have a number of rings of the description above for various jobs that come along. R. B. Casey.

Schenectady, N. Y.

HYDRAULIC STOP COCK AND UNION.

In our factory we use a good many hydraulic cylinders working under about five hundred pounds pressure per square inch, and as the work, while not hard, is continuous, and the cylinders as well as the valves and fittings get very little attention, we have found it practically impossible to keep any of the standard makes of valves or unions from leaking for

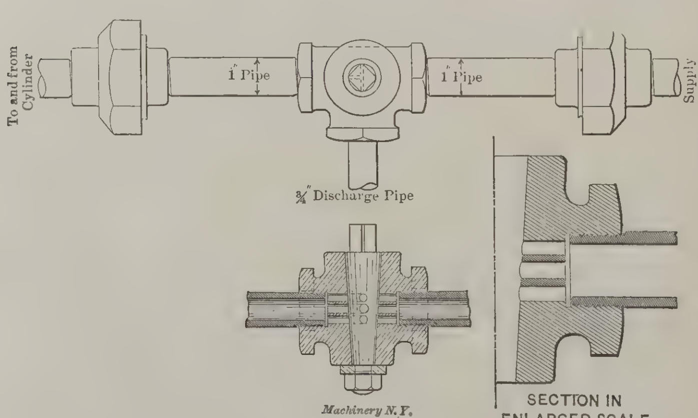


Fig. 1. Hydraulic Stop Cock.

any length of time. We therefore finally designed the three-way stop cock shown in Fig. 1. At first we made both the body and plug from brass, which we found unsatisfactory, owing to the plug cutting out around the opening. We then made some with soft steel plugs, drilled as shown, which have given entire satisfaction. Although these stop cocks are very much heavier than any on the market, yet one of these costs less than two standard two-way cocks, or one standard three-way cock, and will last much longer, as we have had some of them in use for nine weeks, and they do not show any wear or leak, while it was steady work for one man making changes and repairs before.

It will be noticed in the cut that there is a union above and below the stop cock, this being necessary so as to make quick changes or repairs, stop cocks complete with nipples

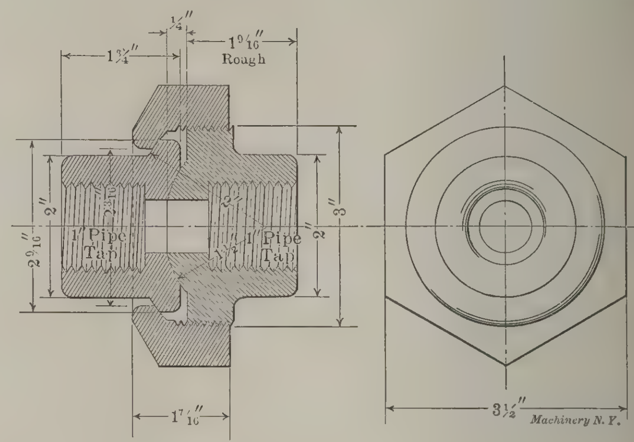


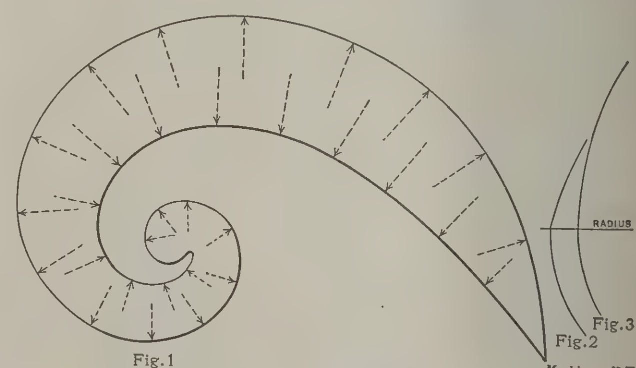
Fig. 2. Hydraulic Union.

and male parts of unions being always kept ready by the pipe-fitters. The standard union was found unsatisfactory owing to tendency to leak, and the supply pipe easily got out of line, so we had unions made, as shown in Fig. 2, which also are very heavy and are in the form of a ball joint which allows for shifting of pipes, and allows the union to be tight without using any gasket at all. These unions have given good satisfaction and are even cheaper in first cost than the standard hydraulic unions at present on the market, as they actually cost but \$2.50 each, while the standard ones cost us \$2.65 each, and these new ones are lasting much longer.

Valley Park, Mo. W. O. Renkin.

JOINING CURVES NEATLY.

There is only one condition under which the end of a curve can be joined neatly to another curve, or to a straight line, so that the two lines shall flow neatly together—and that is



Joining Curves Neatly.

where both the lines are tangent to the same radius at the point of meeting. In any other case there will be a break or sharp place which will be very apparent to the eye; and further, a piece made after the drawing will not be so strong as though the curve flowed regularly. The difference in strength may be hardly calculable, but is there, all the same, and the appearance will always be better where this rule is followed.

There is a very simple way to attain this desired end, and that is to draw at various points on the wooden or other templets, which are used for making simple or compound non-circular curves, radii (or in the case of concave curves, prolongations of radii) to the curve, that is, lines at right angles to the curves at the points chosen.

Fig. 1 shows a logarithmic spiral templet with such radii and prolonged radii marked thereon; Fig. 2, a compound curve drawn therewith without reference to the rule, and Fig. 3, one properly drawn. Robert Grimshaw.

Hanover, Germany.

EFFECT OF CHANGING LOCATION OF CAM ROLLER.

When the line of motion of a follower passes through the center of rotation of the cam, and the angle of the curve causes it to work hard, the curve may be modified, and the same motion of follower obtained by placing the follower with its line of action parallel to its original position and not passing through the center of the cam. A condition may be assumed, as shown in Fig. 1.

Here we have a cam, rotating in the direction indicated by the arrow *A*, whose duty it is to move the follower ¾ inch in the direction indicated by the arrow *B* during a 30-degree angle of motion of the camshaft. The angle of the cam as

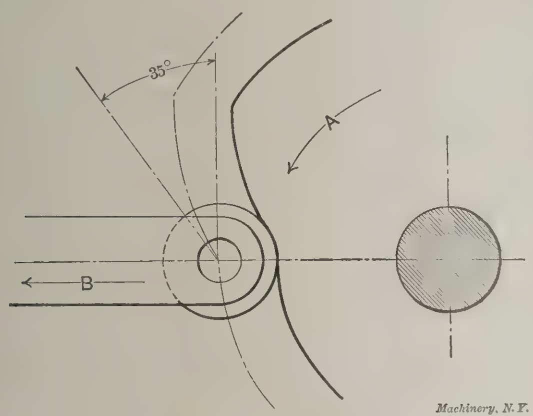


Fig. 1. Cam Roller on Center Line of Cam.

presented to the follower at the beginning of the stroke would be 35 degrees, as determined by the tangent to the curve of the centers, as indicated on the drawing. After the follower had moved one-third of its distance, the angle presented would be 32 degrees, and when two-thirds of the travel had been made, the angle of the curve would be about 30 degrees. The angles given are for a curve which would give a uniform motion to the follower. Should the cam curve work hard at the required speed we would naturally make the cam of greater diameter, if possible, which would reduce the angle of the cam, as shown by the difference in the angles presented in Fig. 1, as we go out from the center of rotation. The design of machine, however, might make

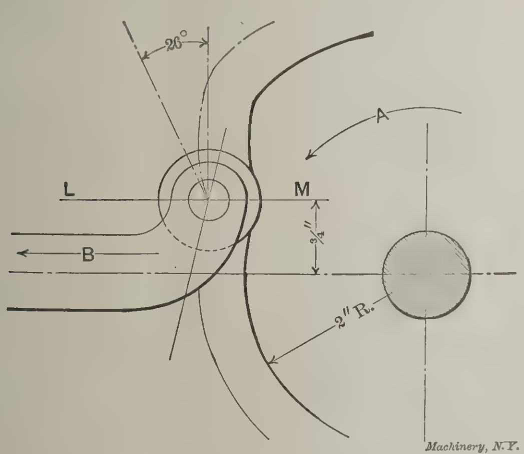


Fig. 2. Cam Roller placed above Center Line of Cam.

this change impossible. If it was simply necessary to get the follower from the position shown to a point ¾ inch distant in a 30-degree movement of the camshaft, without regard to its motion, a harmonic or gravity curve might be used which would cause the cam to work easier. However, this would be impossible should our design require a uniform, or some other equally hard motion. A third way in which the angle of the curve might be decreased would be to make the angle of motion of the camshaft greater. This, too, might be made impossible by the limitations of our design.

Another way, and one not commonly used, is suggested in the opening paragraph of this article. In Fig. 2 all conditions are the same as in Fig. 1, except the roller has been placed ¾ inch above the line passing through the center of the cam. The center of the roller will now pass along the line *L M*, or parallel to the line of motion in Fig. 1. The angle of the curve presented to the roller in this case is 26 degrees, much less than the angle presented in Fig. 1, and the angle decreases as the roller moves away from the center of rotation. The advantage that may be gained by moving the cam roller may be readily seen by comparing the results given above. There is, of course, a limit to the distance the roller may be changed, for if placed too far away from the center line, the thrust in the direction at right angles to the direction of motion of the follower would be so great as to offset the advantage gained.

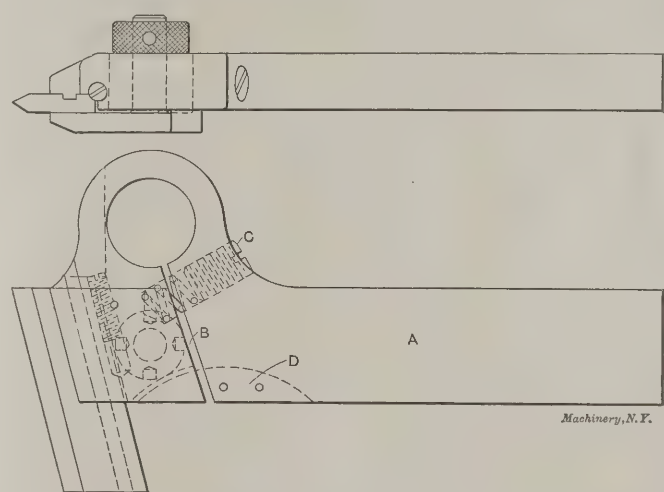
Without the aid of an illustration I think it may be seen that to place the cam roller on the other side of the center would cause the angle of the cam curve to increase, thus making conditions worse. The offset of the roller should be in the direction opposed to the direction of motion of the cam.

Arthur B. Babbitt.

Hartford, Conn.

SPRING HOLDER FOR THREADING TOOLS.

In a large shop in the West, in which I was employed, a number of special thread-cutting tools, such as shown in the accompanying cut, were used. These tool-holders were intended for the blades or single-point cutters made by the Pratt & Whitney Co. The improvement in the design consisted in the provision for permitting the tool to spring away



Spring Holder for Threading Tools.

from the work if too heavy a cut was taken. In other respects the principle of the holder was the same as that of the one manufactured by the Pratt & Whitney Co., itself, for these tools. Referring to the cut, *A* is the body, which is slotted at *B*, proper resistance being given the tool by the setscrew *C* which has a spring at the lower end, acting upon the front part of the holder. The part *D* is an inserted blade or key, which keeps the front part of the holder from bending to one side while cutting. This tool proved to be most popular in the shop. The preference was given to it not on account of its novelty, but because more satisfactory results were obtained than with the ordinary tool-holder.

Jim.

[A great many designs of spring tool-holders have been tried, and the one shown in the cut is comparatively common. The difficulty with holders of this kind is that it is almost impossible to adjust the screw for each particular pitch to be threaded so that the spring has the proper tension. It is evident that in cutting a coarse thread there is no need of the tool being as sensitive as when cutting a very fine thread, but there is no means for judging when in each particular case the proper springing action has been attained. Another objection to the design shown above is that it prevents a full and clear view of the thread being cut, the projecting part extending partly above the work. Of all spring thread-tool holders hitherto designed, however, this one is about as good as any. A spring tool-holder for threading tools which will overcome the objections mentioned is greatly in demand, and many attempts have been made to solve the problem, but as far as we know none has been entirely successful.—Editor.]

FIXTURE FOR SLOTTING ROD BRASSES.

I noticed in the January issue a description of a jig for slotting or planing connecting rod brasses. The author says, "Of course this jig can be improved upon," and for locomotive brasses, which are generally planed perfectly square in most shops, I think the one shown herewith to be an improvement, inasmuch as it is much easier made and also

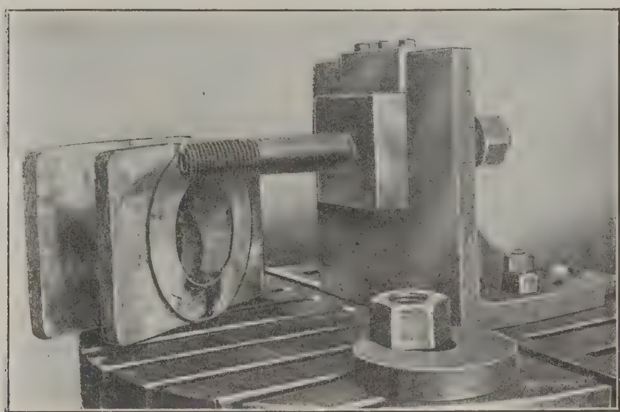


Fig. 1. Fixture for Slotting Rod Brasses.

easier to keep it in good condition. The piece *B* of his jig is rather a difficult piece of work, and the constant wear on the bushes will, I am sure, make it difficult to keep it in such condition that it could at all times be depended upon to turn out a perfectly square job. This piece *B* on the jig as shown in Fig. 3 has been milled square, and when one side of the brass has been machined, the nut behind the angle plate *A* is loosened and the sliding bar pulled forward sufficiently to clear the angle piece or stop *D*, revolved one quarter turn, and slid back under angle stop *D* again. Angle block *D*, of course, must be made to fit snugly down upon the square part of *B*. The two halftones, Figs. 2 and 3, show the jig plainly when used on a machine. OBSERVER.

WHY A MACHINIST WANTS MORE LEISURE.

Mr. Plaisted and his best girl must have had a disagreement to occasion the article which he wrote in the March issue. It is not so long since the writer was in the same position; that is, he was a "greasy mechanic," and had a "best

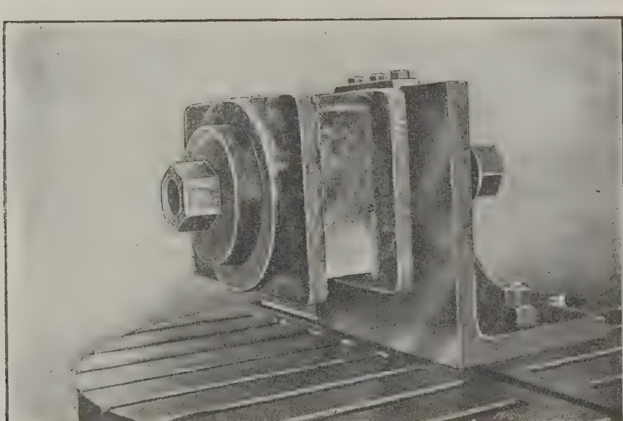


Fig. 2. Work Mounted in Place.

girl," and he can remember about how it seemed. As I recollect it, my best girl did not object so much to the dirt I worked in as to the fact that my work did not give me time enough to spend with her. Part of this was due to the long hours, the time it took to wash up at night, and the fact that I had to get around so early in the morning that, if I wanted to earn my wages, I had to go home before midnight. After she passed the best girl stage, she began to think that I cared too much for the shop. I often had some problem to figure out at home evenings, and there was something that I had to go down Sundays to see to, but it never was the dirt that troubled her; it was just time—and the fact that we could not talk together about my work. To be sure, I told her all about the heads and carriages and saddles and aprons on our tools, but that was not half so satisfying as the colored silks and cloths that one of her other best fellows used to sell. To be sure we had more money to spend than Mr. Drygoods would have had, but what was the good of having the money if I was too tired and pre-occupied to enjoy it with her. Mr. Drygoods had an afternoon off every week and never thought of working a minute on Sunday.

Now what I make of all this is that machinists have been at work all these years building labor-saving machinery to the end that others than themselves might have leisure. A machinist to-day is as steadily at work and longer at work than almost anyone else. What he needs, and what his best girl and better half wants him to have, is more time at home. You give the average machinist the choice of 10 per cent more pay or 10 per cent fewer hours at the old pay, and he will speak for the money quickly, but in a week "she" will have talked him out of it, and he will, if he dares, ask for that 10 per cent reduction of time. And then he will find that it is not merely that he wants to work less, but that he wants more time in a lump. Drop off an hour a day and see how long it will be before your workmen are around to lump it all on Saturday. They do not object to the work, but every one of those men has somewhere a spark of love for his family, and for the woods and fields, that prompts him, as soon as he gets above the point where he is not hungry or cold, to wish for time for himself more than for money.

Now I hope no one will think that because my best girl doesn't like to have me thinking about the shop when I am at

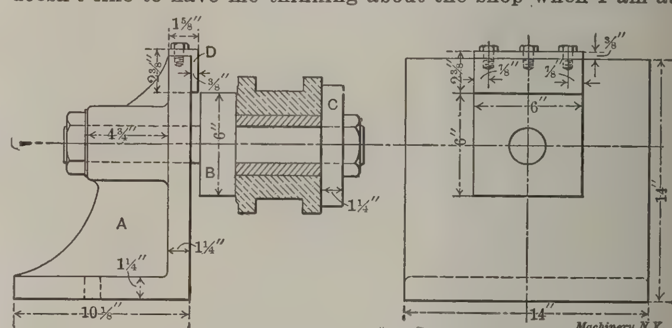


Fig. 3. Details of Fixture for Slotting Brasses.

home, that I think anyone should take no interest in their work; but if you want to be sure that some day she won't "go home to mother," just set aside a certain time for thinking and another for spooning. Mixing the two is a reprehensible as building a combination machine that will not work but one way at a time. Your girl has a right to your undivided attention part of the time, and the shop another part, and sleep another. You can rob your hours of sleep of quite a little with greater safety and more justice than you can your girl. ENTROPY.

THE JARNO TAPER.

I note in your issue of June a table of Jarno tapers. It seems too bad that any one should so far forget the pith and underlying simplicity of the Jarno taper as to give a table in this manner. It is misleading, and inexperienced young men who are readers of MACHINERY are likely to lose all that the Jarno taper stands for when they look at a table made up in this way. It would seem to the writer absolutely unnecessary to prepare such a table and to give it such a mathematical appearance, entirely giving up the fundamental idea, which is its simplicity and the absence of all formulas.

This taper was invented by Mr. Oscar J. Beale, Providence, R. I., and in justice to him and your readers it should be given in exactly the same way that Mr. Beale gave it; that is, a No. 2 taper is 2/8 inch at the large end, 2/10 inch at the small end and 2 halves long. A No. 10 taper is 10/8 inch at the large end; 10/10 inch at the small end, and 10 halves long. Such a proposition as this requires no letters, no signs, no minuses, no pluses, no symbols. It is simplicity itself, and it would seem that any one writing in these practical days for a paper like yours, which stands for the practical shop workman, should not overlook the underlying facts. As for the taper the simple statement that it is always 6/10 inch to the foot is

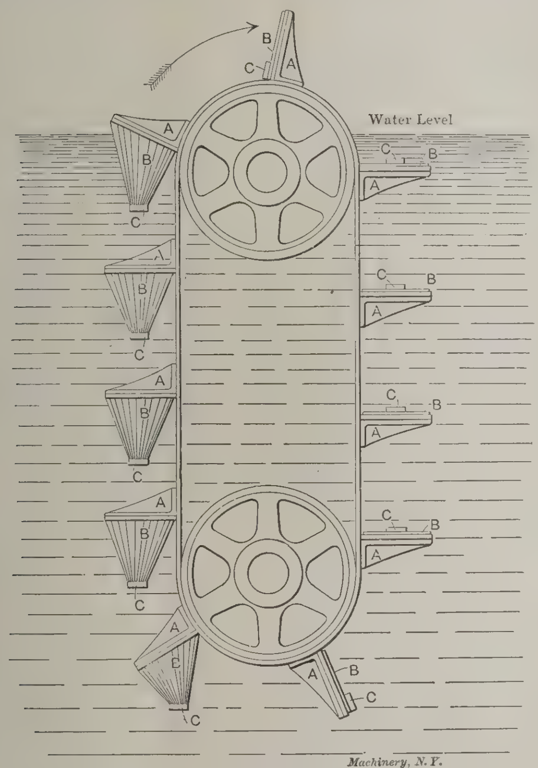
sufficient. One word more is not only unnecessary, but confusing. C. H. NORTON.

Worcester, Mass.

[From one point of view Mr. Norton's objections may be valid, but there seems to be really no very good reason why all such shop data, no matter how simple, should not be tabulated so as to save calculation or to check calculations. We all know the difficulty that some men experience in doing even simple addition without errors.—EDITOR.]

R. S. INVENTS A DEVICE FOR PERPETUAL MOTION.

It has seemed rather cruel to me that all my attempts at startling mathematical discoveries have been refuted by the readers of MACHINERY, and that I have not received much gratification out of the labors I have laid down on the altar of science, but it is gratifying to know that all great men have been misunderstood. My disproval of Euclid became a mournful fiasco, and my venture in algebra turned out nearly as bad. Finally, my laudable endeavor to solve a problem, which requires mathematics of a higher order, by elementary means, has been classified as ridiculous. But all this probably depends upon that I am more of a practical man than a scientist, and for this reason I have turned my interest toward the field of invention rather than that of science. Even if the present generation does not appreciate my discovery, I am sure that future generations will, and I can well imagine how, in a not distant age, huge machines, generating power by means of my perpetual motion, will be utilized for driving all the machinery in the world. All the expense for generating power will then be that of the first cost and repairs, and these expenses will be extremely small on account of the simplicity of the device itself. If I continue to invent as wonderful things as I have done heretofore, it may be that I will be able to overcome even the initial expense.



R. S. Epoch-making Perpetual Motion Device.

In fact, I have invented nothing more nor less than a perpetual motion power generator. The crude principle of this is shown in the accompanying cut. It is so simple, indeed, and so certain in its action, that I am sorry I have not been able to think of anything in connection with it that could be called a "secret process." That is what troubles me. For, as we all know, no invention is worth much except one embodying some well-known "secret process." To return to the perpetual motion, however, it consists of two pulleys on shafts resting on ball bearings. On the pulleys a belt is running, and on this belt several brackets *A* are fastened. To these brackets are fastened rubber or impregnated cloth bags *B*, to which are in turn attached weights *C*, preferably made of lead. The device is sunk into water as shown, and moves as indicated by the arrow. It is evident that when the brackets are on the right-hand side of the device, moving down, the weight *C* falls and rests upon the bracket *A*, and the bag *B*, out of which the air has been pumped, and which thereafter has been hermetically sealed, is compressed. When the brackets have come to the lower end of their travel, ready to move up on the left-hand side, the lead weight pulls down the bag, thereby causing a greater displacement of water and consequently giving to this side a greater tendency to rise than that possessed by the right-hand side. The result is that the device will move constantly in the direction of the arrow.

This scheme is undoubtedly the most perfect solution of the power problem ever attempted. I am just forming a company to start to build this apparatus, and ten years from now I expect to see a great water tank in every factory with one of *R. S. perpetual motion power generators* immersed. Anybody having money to spare may put it in the stock of my company, and depend on the same returns as from ordinary gold-mining stock. R. S.

WHAT IS A MACHINE DESIGNER?

Whether R. E. F., in getting after Entropy in your May issue, really scores his own point, or whether he helped Entropy make his point, is an open question. If I should say that I objected to having drawings for a machine, made by the office boy and proportioned by set formulas, classed as designs, perhaps my position would be better defined. In the world's history there have always been pioneers, men who went on ahead and blazed the way for civilization, roughed it, and broke down the barriers of nature. Then there have followed the army of workers who have smoothed out the rough places and laid out towns and villages and prepared the way for the tenderer and possibly more effeminate ranks of mankind, who have brought the luxuries and refinement of the extreme of civilization. None of these men wished to exchange places with any of the others. The pioneer would no more sit in the parlor of the society man, if he were allowed, than the society man would go out and rough it on the advance line of progress. Just so it is with designers and engineers. The man who has it in him to ride rough-shod over precedent and attack new problems with his hands unfettered by knowledge of what cannot be done, is not the same man that can take a machine already designed, and smooth out its inaccuracies and reduce it to a manufacturable article, nor is he the same man that can design the jigs and special tools that will make it a profitable machine to build. Now, to my mind, neither of these latter men should be classed as designers. Their work is necessary, but it is not (usually) original. To be sure, many kinks and arrangements of jigs are new, but they are not to be compared with the original bold conception of a machine. I had in mind, when writing my original article, perhaps more than anything else, what the word designing means to technical students. In every school of this kind there is a course in machine design, and there are innumerable books on machine design, but there is almost no machine design taught, and there is almost no machine design in the books. What is taught is the smoothing-off process by which the machines which have already been designed, perhaps by the instructor, perhaps by someone else, are brought down to a basis to which a little theory and some precedent may apply, but of real design these chaps know nothing, and they probably will continue to know nothing when they graduate, till R. E. F. and Entropy both are gray and feeble. These boys will tell you that they have studied machine design and can design machines, but they will have to see one like it before they can begin. Now all that I ask is that the man who can start out with nothing tangible and produce a machine that will work be called a designer, and that the man who turns a crank and drops a formula in the hopper be called something else, I don't care what. ENTROPY.

SHOP KINKS.

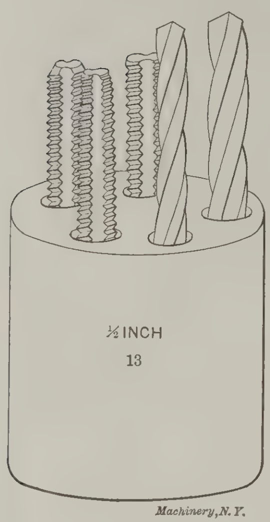
A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

TOOL FOR APPLYING COPPERIZING SOLUTION.

Take a piece of small glass tubing and draw a wire through it, bending the wire so that a tuft of cotton or wool can be placed in the loop. When the cotton becomes soiled, it can be readily substituted by a clean piece. The glass protects the fingers. H. A. S.

HOLDER FOR SETS OF TAPS AND TAP DRILLS.

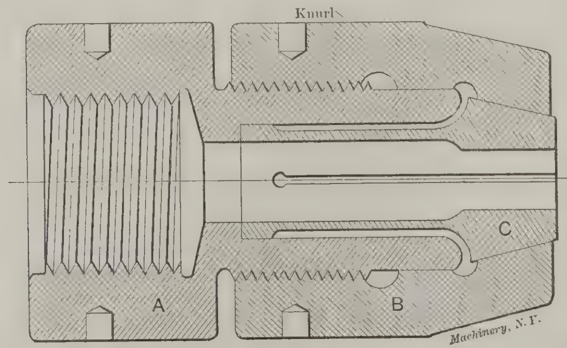


In the cut herewith is shown a convenient means for keeping sets of three taps with the tap and body size drills. The holder for the taps and drills is made from maple or any other hard wood, although pine will do if a higher grade of wood is not at hand. The five holes drilled in the holder are drilled nearly through the block, in order to permit the tools to get as long support in the block as possible. Otherwise they are liable to fall out easily, and are a constant annoyance. The blocks with the sets of taps and drills are kept in the tool room. This system saves much time ordinarily lost in hunting for the proper drills for a certain size of taps.

WINAMAC.

CHUCK CLOSER FOR SCREW MACHINE COLLET.

The chuck closer shown in the accompanying cut is inexpensive and very practical in a small tool-room, where the management will not furnish a tool-maker's lathe with draw-in

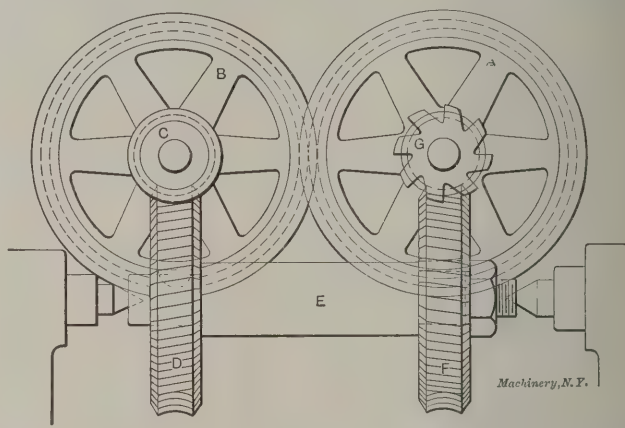


chuck. The holder A screws onto the lathe spindle, the closer B, in turn, screws onto the holder, and the collet C is held in the holder and acted upon by the closer. F. J. PERRY.

Lowell, Mass.

RIG FOR HOBBING WORM-WHEEL.

In the cut is shown a hobbing rig for worm-wheels, used on a milling machine. This rig consists of two gears A and B, meshing with one another, one worm C, one worm-wheel D, and an arbor E. F is the worm-wheel which has just been hobbed, and G is the hob. This hob is mounted on an arbor inserted in the spindle of the milling machine in the usual way, and the gear A is mounted on the spindle also. A special bracket is placed on the milling machine table for holding the gear B and the worm C. The arbor E is placed between the centers on the table, and the worm-wheel D meshes with the worm C mounted on the same stud as gear B. The worm-wheel and worm must be of the same pitch and of the same diameter, respectively, as the hob and the worm-wheel to be cut, but must have the teeth cut in the opposite direction; that is, if a left-hand worm-wheel is to be cut, the guiding worm-wheel D must be right-handed. This rig enables gears to be hobbed or cut in one operation by simply putting the gear blank on the arbor, inserting it between the centers as indicated, and feeding the table upward until the proper

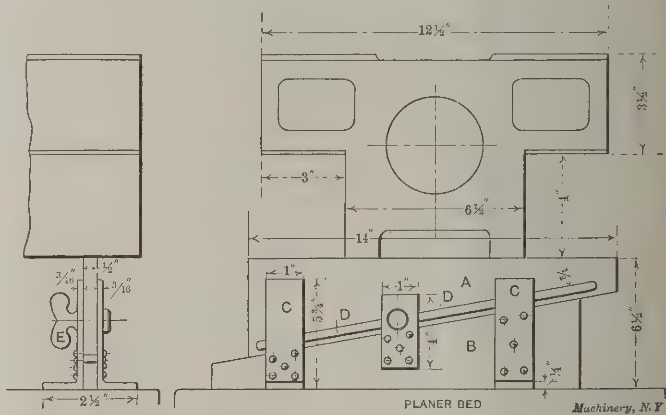


depth is reached. Gears from 2 to 6 inches in diameter can be cut very quickly with this arrangement.

Chicago, Ill. A. ANDREWS.

DEVICE FOR SUPPORTING AND LEVELING CROSS-HEADS.

In the line cut herewith is shown a device for supporting and leveling a cross-head which is supposed to be resting in a V-block on the planer. The device needs but little explanation, as it simply consists of two wedges A and B, the latter being



stationary and provided with four angle irons C C, which serve as feet and at the same time extend upward and act as guides for the top wedge A. The slot D allows motion to the upper wedge endwise. Through this slot passes the thumb screw E, binding the wedge when driven into place. By lightly rapping in the wedge before the work is tightened down, it at once assumes a position parallel to the planer table, thus eliminating much trouble in measuring and calipering. This device has proven to be a great convenience, and to be much handier and quicker than any other method. It supports the work in a substantial manner, and it saves time.

Clinton, Iowa. H. W. HARRISON.

INSPECTING INSIDE THREADING IN SMALL HOLES.

It is always desirable to be able to inspect closely the interior of a hole of small diameter, especially when threading it. For this purpose a slip of mirror is often recommended. Something still better is a dentists' little concave mirror, aided by an electric incandescent lamp and a concave mirror; but best of all, up to date, is a new dentists' appliance, consisting of a handle about as large as a stylographic pen, and containing a tiny incandescent lamp with mirror in the holder, while a second concave mirror is attached to the end of the holder at such an angle as to permit its use in the mouth or a bored hole. I suppose S. S. White & Co., of Philadelphia, make such an appliance; in Europe they are made by C. Ash & Son, London and Berlin. ROBERT GRIMSHAW.

Hanover, Germany.

SHOP RECEIPTS AND FORMULAS.

A DEPARTMENT FOR USEFUL MIXTURES.

This page is intended to be used only for the publication of such shop receipts as the contributors know from experience to be practicable. Receipts are solicited on the condition that the contributors personally know that they are reliable. The fact that a receipt is old and supposedly well-known does not bar it, provided it has not already appeared here.

366. WATERPROOF MARKING PAINT FOR STONE.

To prepare a marking paint for use on stone where exposed to the water and dampness, use pitch, 11 pounds, lamp black, 1 pound, and heat carefully, adding sufficient turpentine to give the mixture the desired consistency. M. E. CANEK.

367. COATING IRON OR STEEL.

Iron or steel may be given a permanent coating of yellow brass by using a flux of boracic acid and then dipping into a pot of melted spelter, afterwards wiping off the article while still hot. The electro-plating process, however, is the best for this purpose. A coating of copper should then first be deposited on the steel, the same as if it were to be nickel-plated, and then follow with an electro-plating of yellow brass.

Cleveland, Ohio. L. MILLER.

368. TO CLOSE CRACKS IN CASTINGS.

The following mixture has been successfully used in filling cracks in gas engine water jackets, and is similar in nature to the ordinary rust joint mixtures. Prepare a dry mixture of 17 parts of cast-iron filings, 2 parts of sal-ammoniac, and 1 part of flour of sulphur; add twenty times the weight of new iron filings, put in a mortar and add water so as to obtain a paste. This paste is applied to the crack, and in a short time becomes as hard as the metal itself. M. E. CANEK.

369. CEMENT FOR UNITING GLASS AND BRASS.

It is often necessary, in electrical factories and repair shops, to cement small brass parts to glass. A good cement for this purpose is made from the following: 1 part caustic soda, 3 parts resin, 3 parts plaster of paris, 5 parts water. Boil all the constituents together until thoroughly mixed, and then allow to cool before using. The cement hardens in half an hour. If it is desired that it should not harden so quickly, substitute zinc white, white lead, or slaked lime, for the plaster. T. E. O'DONNELL.

Urbana, Ill.

370. CEMENT FOR SWITCHBOARD REPAIRS.

A good cement for making repairs on switchboards, when iron or other metal has to be fastened to marble, or where binding posts have been pulled out, may be made to consist of 30 parts plaster of paris, 10 parts iron filings, and ½ part of sal-ammoniac. These are mixed with acetic acid (vinegar) to form a thin paste. This cement must always be used immediately after being mixed, as it solidifies if allowed to stand for any length of time. It will be found to be an excellent means for filling up old binding-post holes, when instruments have been moved. T. E. O'DONNELL.

Urbana, Ill.

371. CEMENT FOR HIGH-PRESSURE WATER PIPE JOINTS.

A highly recommended packing and cement, combined, for making tight joints in high pressure water pipes, is made as follows: Mix with boiled linseed oil, to the consistency of putty, these ingredients: Ground litharge, 10 pounds; plaster of paris, 4 pounds; yellow ochre, ½ pound; red lead, 2 pounds; cut hemp fiber, ½ ounce. The hemp fiber should be cut in lengths of about ½ inch, and thoroughly mixed into the putty material. Its office is to give consistency to the cement. The cement is applied to the joint similarly to any other cement. It dries thoroughly in from 10 to 12 hours.

Urbana, Ill. T. E. O'DONNELL.

372. FOR WASHING SHOP WINDOWS.

Soap and water are poor materials with which to wash greasy and dirty shop windows. The labor cost is excessive; the soapy water gets into the joints of the window sashes and hastens decay; and there is liable to be a good deal of soapy water slopped over benches, tools and machines. The quick way, the economical way, and the good way, is to use the following preparation, which has been used by the writer with good success and satisfaction for the past ten years. Dilute alcohol with three times its bulk of water. Stir into this whiting enough to thicken it somewhat. Apply this to the glass with a cotton cloth or waste. Leave it fifteen or twenty minutes to dry. Then rub off with a cotton cloth or a handful of waste. If sashes are to be painted, there will be no need of a long wait for the wood to dry, as the alcohol will very much hasten the evaporation of the water and leave the woodwork in fine condition for the painter. OSCAR E. PERRIGO.

Peabody, Mass.

373. TO PREVENT HOT LEAD STICKING TO WORK.

About three years ago we had a new quick-break switch to manufacture in large quantities. One piece of the switch was required to be hard at one end and soft at the other. We tried several methods of annealing so as to leave one end hard, but found that the temper was drawn throughout, and all were rejected. We finally decided that a hot lead bath was the only way that would anneal one end and leave the other end hard, but we then encountered the difficulty of the hot lead sticking to the work. A number of receipts were tried for preventing it without success, but finally I discovered a process that is quick and very cheap. Mix common whiting or cold water paint with wood alcohol and paint the part that is to be annealed. The hot lead will not stick, no matter how long the piece is held in the pot. Of course, in the work mentioned, the pieces were lowered quickly into the hot lead and removed as soon as possible, in order to prevent drawing the temper of the hard end, and then the whole was plunged in a pail of cold water. Water will do as well as alcohol to mix the paint, but alcohol is the most convenient inasmuch as it can be used without waiting for the paint to dry. If water is used, the paint must be thoroughly dry, as otherwise the moisture will cause the lead to fly. E. J. LAWLESS.

Pittsfield, Mass.

374. LACQUER FOR BRASS.

I have found that the following process makes a very good lacquer for the brass parts of fine instruments, and that it requires but little labor to prepare. Make four alcoholic solutions in separate bottles of each of the following gums: unbleached shellac, dragon's blood, annatto, and gamboge, in the proportions of about one ounce of the gum to a pint of alcohol. Keep these solutions about a week in a warm place, on a hot water or steam radiator, for instance, shaking the bottles frequently. It will be found that the alcohol will not dissolve all of the gum, but that within half an hour after shaking, a precipitate will settle on the bottom of the bottle, leaving a perfectly transparent but highly colored liquid above, which deepens in color from day to day. Decant this off, and filter through cloth, placing the liquids in tightly corked bottles. A word of caution should be given in the case of shellac. Most readers of MACHINERY are familiar with the yellow opaque shellac varnish of the pattern-maker. This is useless. But if the above proportions are used, and the solution kept warm, say 130 to 180 degrees F., a light flocculent precipitate will settle out, leaving a transparent wine-colored liquid above. It is this liquid which must be used. The four solutions should now be mixed. Equal parts of each give a rich golden yellow. After mixing, the solutions should be boiled down to about one-third of the volume, great care being used not to ignite the alcohol. Heat a piece of cast-iron over a Bunsen burner, and as soon as this is hot, turn out the burner and place the solution on the iron and allow it to boil. When it ceases to boil, repeat the process. When cold, this solution may be applied with a brush to the brass in the usual way, the brass having been polished with fine jewelers' emery paper, and slightly warmed. Though slightly harder to apply than the commercial lacquers, it possesses none of the disagreeable odor of the banana oil which they contain.

Columbus, O. H. C. LORD.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

C. H. A. I would like to ask the readers of MACHINERY what I can do to remedy the following difficulty: When copper-plating cast iron by dipping in a copper sulphate solution, the castings have been turning dark and rust while drying, whether dried in sawdust or open air. I have tried thoroughly cleaning in caustic soda. Is there any sure way of doing this plating by dipping in copper sulphate ($CuSO_4$) so as to obtain a plating that is good? What are the correct solutions and best methods?

CALCULATIONS FOR SHORT TOOTH GEARS.

L. A. F. What is the meaning of "11/14 pitch," a term which I found applied to an internal gear and its pinion on a drawing in my possession? How can I figure the pitch and outside diameters for an internal gear having 138 teeth meshing with a spur gear having 60 teeth, 11/14 pitch?

A. The fractional pitch referred to without doubt relates to a method of designating a short tooth form of gearing, which has been considerably used, especially in automobile work. The figure 11 in the numerator of the fraction refers to the actual diametral pitch of the cutter, and should be used in all calculations relating to the pitch diameter. The figure 14 in the denominator indicates that the length of the tooth is the same as that of the 14-pitch size, although the pitch is really 11. The pitch diameter of the 138-tooth internal gear would be $\frac{138}{11} = 12.5454$ inches. The pitch diameter of the 40-tooth gear will be $\frac{40}{11} = 3.6363$ inches. In reckoning the outside diameter of the pinion and the inside diameter of the internal gear, proceed as if the gear were 14 pitch. The addendum (the distance the tooth extends above the pitch line) for a 14-pitch gear equals $\frac{1}{\text{pitch}} = \frac{1}{14}$. Twice the addendum added to the pitch diameter will give the outside diameter of the pinion, $3.6363 + 2/14 = 3.7791$ inches; likewise, $12.5454 - 2/14 = 12.4026$ = inside diameter of internal gear.

In a system in common use and recommended by the Fellows Gear Shaper Co., of Springfield, Vt., this short form of tooth has a length of as nearly ¾ the standard length as can be expressed in the form of an even diametral pitch. That is to say, if we wish to express in fractional form the pitch of a short 11-pitch tooth, we have: $11 \div \frac{3}{4} = 14 +$; 14 will then be the denominator of the fraction, giving us 11/14, as was stated by our correspondent. In the Fellows form of gearing mentioned, the pressure angle is made 20 degrees instead of the standard 14½ degrees of the ordinary gear cutter. This gives a stronger tooth, and one with less interference as well in the case of low numbered pinions.

COUNTERBALANCING CRANK-SHAFTS.

D. L. Please give me a formula for finding the balance weights that I want for a two-cylinder four-cycle gasoline motor with a crank-shaft like that shown in Fig. 1, in which *B* are the journal bearings, and *P* the crank-pins.

A. It will not be possible to give you any definite formula for solving this problem. The matter of balancing an engine arranged like this is a compromise; it cannot be balanced

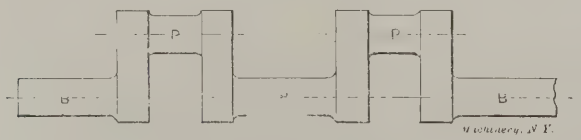


Fig. 1.

completely. The rotating parts may be taken care of, but it is impossible to absolutely balance the piston and connecting-rod by rotating counterweights. The following solution, however, is offered as representing average practise. It should give a fairly quiet engine: First find the amount of counterweight required for balancing the rotating parts. Aside from the connecting-rod and its parts, it is assumed that the crank-shaft itself is the only unbalanced revolving weight. Support this, as shown in Fig. 2, on the ways of a lathe or any other convenient level track, so that the main journals are free to roll on the top of the ways. Suspend one of the crank-pins from a wire loop hung from a spring balance. With the center line of the crank horizontal, and the spring balance hold vertically, note the weight shown on the scale. Add to this 75 per cent of the weight of the connecting-rod with the brasses, oil cups, etc., in place, and 60 per cent of the weight of the piston with its rings, wrist-pin, etc. The result, which we will call W_1, will be the weight necessary to approximately counterbalance the engine when the weight is located with its center of gravity directly opposite the cranks, half way between them, and at a distance equal to the throw of the crank from the center line of the crank-shaft. Since it will not be feasible to locate the counterweight in this

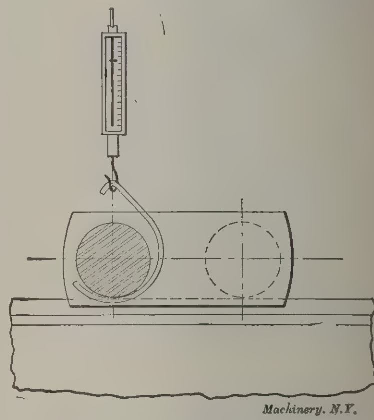


Fig. 2.

way, it will be necessary to distribute it in two or more separate portions according to the rules illustrated in Fig. 3. Calling the weight just obtained W_1, and the crank radius R_1, we have $W_1R_1 = W_2R_2$, where R_2 is any other radius, and W_2 the corresponding weight required. This weight W_2 may be divided, one being moved to one side and one to the other in double flywheels, for instance, or on the outer crank arms if desired. If they are moved equal distances, *b*, to either side of the center line, the weights may be evenly divided as shown. No matter how the counterweights are distributed, however, or what their number may be, the center of gravity of the

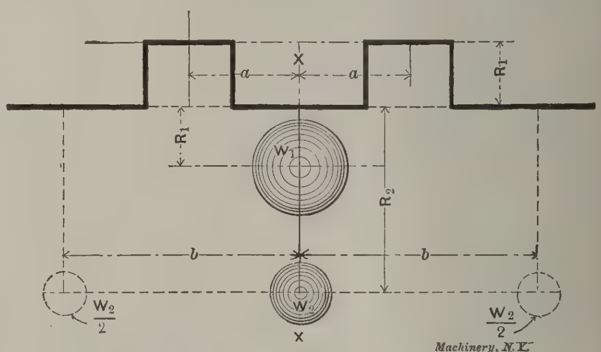


Fig. 3.

whole of them taken together must lie in the center line *x x*, and the sum of their weights must be such that, multiplied by the distance of their center of gravity from the axis, it will equal W_1R_1. If you have a little knowledge of mechanics, or are willing to study the subject, you will find more accurate methods of counterbalancing discussed in various text-books. Of these we would recommend Goodman's Mechanics Applied to Engineering, published by Longmans, Green & Co., New York, and Steam Engine Theory and Practise, by William Ripper, published by the same firm.

One of the causes of unexplained failures of tools is the bad practise often followed by toolsmiths of nicking a steel bar cold and breaking it off. While it is a convenient method, it should not be followed as common practise, but in case a bar is cut in this manner, the fractured end should be cut off at a low heat with a hot chisel. Mr. Taylor, in his notable presidential address, calls attention to this practise, saying that it is a common cause of slight invisible cracks, which may not fully develop until the tool is in use. Tool steel is a peculiar material and there is much about its structure that is not understood, but it is pretty safe to say that anything seriously affecting the molecular structure while in the cold and solid state should be carefully avoided.

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

THE PRATT & WHITNEY OPEN TURRET LATHE.

This article, with its accompanying half-tones and line cuts, describes a new form of turret lathe developed by the Pratt & Whitney Co., of Hartford, Conn. They call it the "Open Turret Lathe," one of the principal points of novelty being the method of clamping the turret tools in position. In bringing out this machine it has been the aim of the builders to produce a universal tool, suitable for doing a great variety of work from the bar as well as on forgings and castings, without requiring special appliances and expensive cutting tools. To accomplish this purpose, many new features, including a cross sliding turret, have been introduced. Particular attention has been paid to rigidity of the whole structure, to power in the drive of the spindle, to the furnishing of quick changes of speeds and feeds, and provision for numerous adjustable stops so arranged as give narrow limits of error for both longitudinal and cross movements. Besides this, the machine possesses, to a great degree, the flexibility and adaptability of the engine lathe.

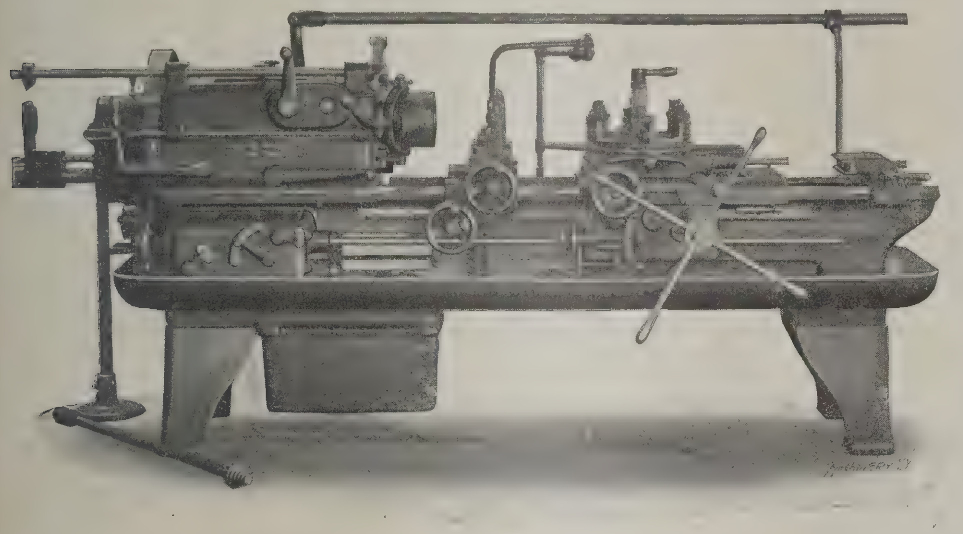


Fig. 1. General View of the Open Turret Lathe.

Design of Head-stock and Spindle.

A general view of the machine is shown in Fig. 1. The head-stock is of the single-speed driving-pulley, and all-geared type, with the mechanism enclosed in a case and subject to constant lubrication. A view of the head-stock with cover removed is shown in Fig. 2. The direction and speed of the spindle are governed entirely by friction clutches controlling the transmission gearing. The starting, stopping and reversal of motion is obtained by lever *A*, operated by the rod extending across the back of the machine as shown in Fig. 1. Levers *B* and *C* operate each two friction clutches, any one of which may be engaged, to give the speed it controls. These clutch levers are operated in an interesting manner. At the front of the machine is a handle *D*, which, by the gearing shown, rotates cam shaft *E* and cams *F* and *G*, which operate clutch levers *B* and *C*. Handle *D* may be set in any one of four positions to engage either of the four clutches. The cams are so arranged that a complete revolution of the handle will engage them in turn, in their proper order to give a consecutive increase or decrease in speed, without the possibility of engaging two at a time. This is much more convenient than having to operate the clutch levers directly, with the possibility of making mistakes in their engagement. A further change of speed is obtained by the horizontal lever shown near the base of the head-stock in Fig. 1. This operates what corresponds to the back gears in an ordinary lathe, multiplying the changes otherwise obtainable by two, giving eight in all. This is ordinarily sufficient, but a two-speed countershaft may be used if desired.

The spindle is unusually heavy, of special steel, and runs in cylindrical bearings in bronze sleeves. These fit conical seats in the head, and are adjusted for wear by being drawn in and locked in position by annular nuts at either end. The thrust of the spindle is taken against an independent upright, shown at the right of the large driving gear. This is cast solid with the head and insures against any springing tendency of the spindle under heavy end cutting strains. Wear in the thrust bearings can be adjusted as it occurs.

The Automatic Chuck.

A sectional view of the chuck for bar stock is shown in Fig. 3. The outer sleeve *J* slides under the influence of the chuck lever, on the body of the chuck *K*, which is screwed to the spindle *L*. The chuck jaws *M* fit in a double conical seat in the body of the chuck, and are well supported at their extreme outer end, a matter which is particularly desirable in forming work with the cross slide. A lip is formed at the rear end of the four separate pieces composing a set of chuck jaws. This lip enters a recess formed in the closing piece *N*. This closing piece is normally forced outward by a set of springs (of which one is shown in the cut) acting on studs screwed into its periphery. The chuck jaws are thus forcibly opened when not otherwise constrained. To close them, struts *O* are provided, one end of each bearing against a seat on closing piece *N*, while the other abuts against sleeve *J*, and adjusting ring *P* threaded to the body *K*. When the outer sleeve is slid backwards to the extreme limit of its travel, the ends of the struts are allowed to drop into the space left by the enlarged inner diameter of sleeve *J*, thus presented. This allows closing piece *N* to be pushed forward by the springs, and the chuck jaws to be opened. The reverse action takes place when the chuck is closed. The various parts of the mechanism are hardened, the jaws as well as the cylindrical moving parts being hardened and ground. The complete chuck can be readily removed from the spindle, when combination lathe chucks or special face-plates may be substituted.

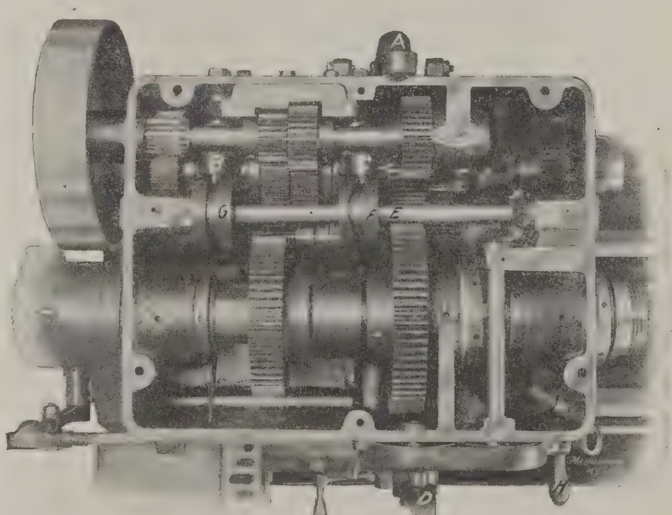


Fig. 2. Head-stock Opened to show Driving Mechanism.

Rod Feed Mechanism.

The lever which opens and closes the jaws of the chuck also controls the rod feeding device. Various lever feeds, weight feeds, friction feeds, and roller feeds have been tried for screw machines, but the builders of this tool have satisfied themselves after long experiment, that nothing has been found

to equal the positive screw feeding device for moving the bar stock forward to its stop. The bar that is to be fed may be round, square, hexagonal, or of any cross-section, and need not necessarily be free from scale, as there are no delicate parts or complicated gearing to become clogged thereby. Details of this mechanism are shown in Fig. 4.

The lever controlling the chuck, operates the feed mechanism by the long connecting link seen in Fig. 1. When the

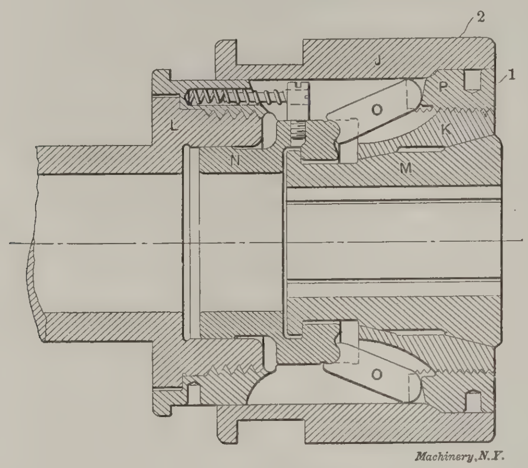


Fig. 3. Details of Automatic Chuck.

jaws are open, clutch Q, together with the coarse pitch feeding screw R, is moved to the right, until it engages with a clutch on the face of gear S, which meshes with gear T on the rear end of the spindle. This gear rotates positively in one direction only. When the two clutches are engaged, the feeding screw rotates, causing the rod follower U to bring the bar of stock forward, acting on it through the collar V which is clamped to the bar. The movement of the bar is arrested by an adjustable swinging stop in front of the head. This stop, best seen in Fig. 1, consists of a stiff swinging arm automatically disengaged in a similar manner. A follower bar is furnished which enables short pieces of stock to be as conveniently handled as long bars, at the same time keeping such pieces concentric with the spindle.

Design of Turret and Turret Feed Mechanism.

The form of the turret is the result of considerable thought. It is the outcome of the recognized necessity for locating the various tools with precision, and giving them at the same time a rigid backing so that heavy cuts, facing, etc., can be accomplished without spring or displacement. These features, with a rigid binding device for clamping the turret to the base, are incorporated in the design shown. This is best seen in Fig. 5. The binding device provided permits long bars to pass through a hole in its center. This feature is common to all Pratt & Whitney turret lathes. The experience of the builders has inclined them to the belief that, even with accurately dimensioned lock bolts and close fitting turrets, more bad work and annoyance has been caused by loosening of the turret than by any other feature on machines of this class. The locking bolt is accurately fitted to the slide with means for taking up the wear without disturbing any other detail. An important point in favor of the horizontal locking bolt as compared with the vertically moving variety, is that the tendency to lift the turret from its seat by the thrust of the lock bolt spring, is obviated. The method of withdrawing the lock bolt and indexing the turret does not require any overhanging bars or increased floor space beyond that taken by the bed. The indexing is automatic, although it is possible to rotate the turret directly by hand when desired.

The power longitudinal feed is positive in both directions, and has six changes, any one of which may be instantly set by the movement of a lever; the changes are accomplished by a sliding key without stopping the spindle. There are six automatic longitudinal stops, and six supplementary ones, giving twelve stops in all which may be used for one or all of the tools in the turret. These stops are held in a heavy steel

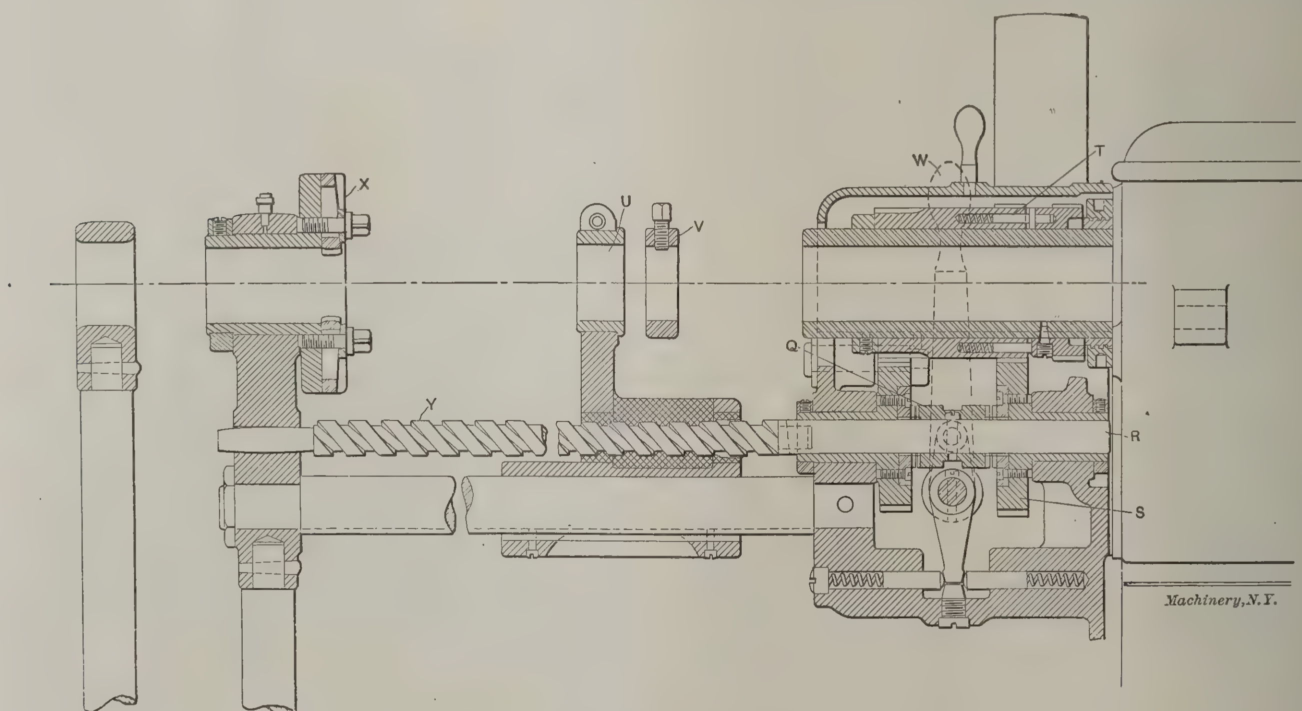


Fig. 4. Rod Feed Mechanism.

mounted on a bar, moving longitudinally in uprights cast solid with the front side of the head-stock. An adjustable clamping ring determines the working position of this stop. When not in use, it is swung upward and pushed back so as not to interfere with the tools.

When the movement of the bar of stock is arrested by coming in contact with the stop, the effect of this resistance is to cause the follower U to become stationary, together with the revolving feed screw R, whereupon clutch Q automatically releases itself from the clutch on the face of gear S. By throwing the clutch lever to the left, the follower may be returned to its rearward position, where the screw becomes bracket, as shown in Fig. 1, which may be moved along the front of the bed and clamped where desired. A swinging arm, backed positively by the main casting of the apron, is connected with the turret mechanism in such a way as to be shifted to one of six different positions in turn, as each of the six faces of the turret is presented to the spindle. For bringing the abutment in line with the intermediate stops, a latch is provided which frees the swinging arm from the control of the turret. The supplementary stops will be found useful when the regular ones have been previously adjusted to suit a long run of work which it is not desired to change. A short job may be put through the machine by using these

supplementary stops, without disturbing the original adjustment, after which the machine may go back to its regular work. The mechanism being at the front of the machine, it is particularly accessible, and its location is such as to prevent lodgment of dirt and chips at the acting surfaces, and thus cause a variation in the turret position.

An important feature in the design of this lathe is the compound turret slide, giving either longitudinal or cross feed by hand or power, with rigid and numerous positive stops provided for both movements. When it is desired to use the cross feed, the carriage may be clamped firmly to the ways at any point in its travel. Eight positive stops for the cross movement are provided. These are best seen just beneath the cross slide in Fig. 5. They may be quickly adjusted and locked by the crank shown. The knob at the front of the cross slide just above them brings a positive abutment within range of any one of them.

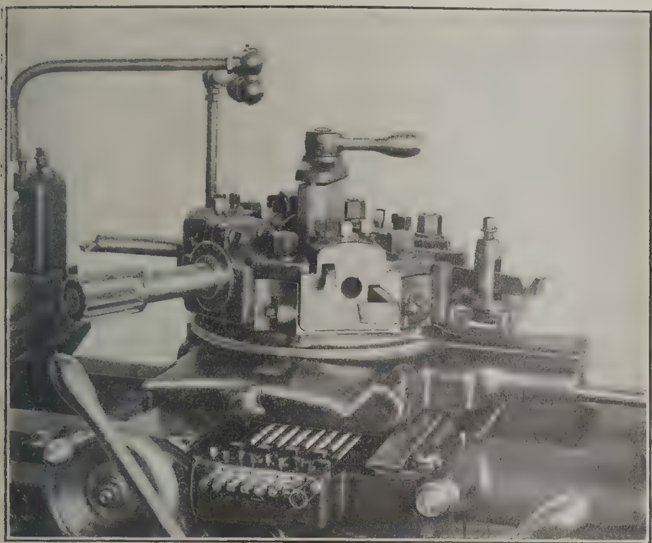


Fig. 5. General View of Turret with a Set of Tools for Castings in Place.

The power cross feed will be found very useful in facing large diameters. In order to guard against the breakage of the gearing which operates the feed, an adjustable friction driving device is used. A central position of the turret is often required, especially when using drills, reamers, dies, taps, etc. To furnish a central stop, the nut for the cross feed screw is brought against a stop plug firmly fixed in the bottom slide, there being no intermediate parts to produce accumulated errors. This arrangement provides an accurate means of locating the turret.

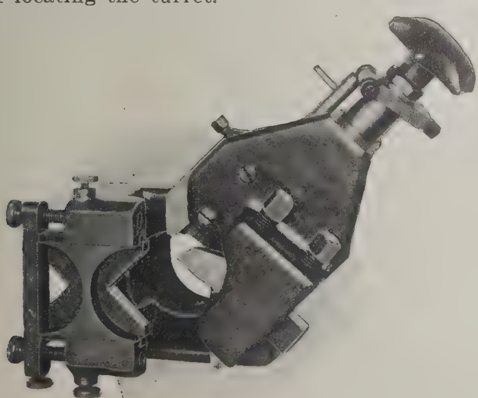


Fig. 6. Standard Turning Tool for Bar Stock and Forgings.

The traverse movement of the spindle head, and the similar movement of the turret slide, are the only methods possible of altering the distance from the axis of the spindle to the center line of the various tool-holders used. Both methods have been practically applied. The former has the disadvantage of leaving long bars of stock projecting from the rear of the spindle without support, when bar work is being done. There is also the trouble of attaching motor drives, due to extra weight if fastened directly to the head, and to the varying belt tension when the head is otherwise driven. Besides, the action of the turning tools and belt strain is to lift the head and hold down the turret slide, and these forces are in opposition. With the plan used in this machine, all strains in the cutting tools in turning, facing, forming, cutting-off, etc., are downward, tending to hold the parts of the compound slide more firmly together, and communicate the pressure to the unyielding bed. Long bar work can always be supported at the rear of the spindle by stock supports, nor are difficulties presented by either motor or countershaft drives.

A special forming cross slide shown in place on the machine in Fig. 1 will be furnished to order. This is used for heavy forming done on bar work or small castings. The feed is by hand-wheel and screw. It has a longitudinal hand feed on the bed in addition to its cross feed, through the hand-wheel shown, with attached gearing meshing with a rack underneath the way of the bed. When using the turret close to the spindle, the cross slide is moved directly under the spindle nose and does not in the least interfere with the turret.

The Turret Tools.

A number of interesting turret tools have been designed for use with this machine, both for bar work and castings. The principal tool used on bar work is the universal turner, shown in Fig. 6. This is similar in design to the turning tools used on the smaller screw machines built by the same firm. It will take cuts up to 2½ inches in diameter, and may be used when turning toward the spindle, as is usual on short work, or away from it, which is frequently desired on long, slender work. The blade is of high-speed steel held in a slot in the tool-slide by two set-screws. This blade is of the "over-shot" type, cutting on its end. It is set for the diameter desired, by adjusting the slide on which it is mounted, by means of the knob shown, with its attached screw. A positive stop is provided, which makes it possible to withdraw the tool from the

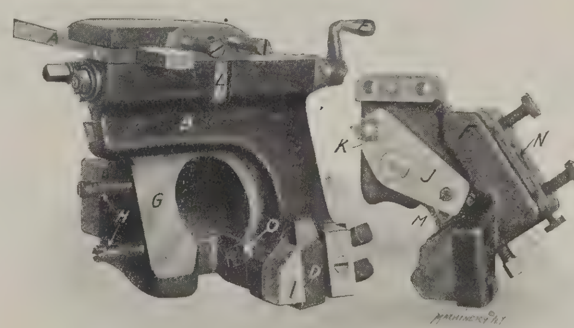


Fig. 7. Automatic Taper Turning Tool.

work and bring it back again accurately to size as often as is necessary. The back rests are of the V-type, quickly and conveniently adjusted to present the correct relation to the cutting tool. The adjustable strap which holds them in, may be quickly swung out of the way to remove them when passing over shoulders, changing cutting tools, etc. This may be done without altering the adjustment. The tool is also furnished with roller back-rests for high-speed roughing operations.

Another interesting tool is the taper turning device, shown in Fig. 7. The taper bar shown at *A*, at the forward movement of the turret, strikes a stop on the head-stock which forces it backward as the tool advances. A lateral motion is thus given to slide *B* from the action of the taper side of the bar on block *C*, which is pivoted to the slide. A block is used at this point instead of a roller to insure permanent accuracy of action. Slide *B* carries the turning tool *D*, which is adjusted for diameter by handle *E*, provided with a graduated collar. Casting *F*, shown removed in the cut, is normally fastened to the body *G* of the tool by screws *H*. This casting has pivoted to it a lever *J*, carrying a pivoted block *K*, which slides in the groove *L* in slide *B*. The other end of lever *K* is pivoted at *M* to a block engaging a slot in slide *N*, which carries the adjustable back-rest jaws. It will be seen from this that, with the parts correctly proportioned, the cross movement of the tool *D* in turning the taper will be duplicated by slide *N*, in the proper ratio to keep the back-rest jaws

always in contact with the work. To insure ease of action, the pressure of the cut against slide *B* is taken on a roller, *O*, instead of against a sliding surface. For work on forgings, the back-rest jaws are set to follow the cutting tool, and move as described to suit the varying diameters produced. For bar work, however, in case bright rolled stock is used, the slide holding the back rest jaws is clamped to prevent movement, and the jaws reversed so as to precede the cutting tool.

The method of holding the tools in the turret is best seen in Fig. 5. The bodies of the various tools are machined with rectangular surfaces to fit the planed seats in the "open turret" used. They are held in place by the short straps shown between the tools. Fig. 5 shows the machine set for work on castings, and the functions of the various cutter-holding devices there used will be readily understood.

Among the other tools furnished are: an open side turner for use instead of the universal turning tool on short, stiff work; a bell mouth pointing tool; an end forming and pointing tool; a turret cutting-off and forming tool; a self-opening die, etc. For castings, a triple tool-holder for boring and turning is furnished, together with end facing and recessing tool, facing and boring tool-post holder, offset single and double tool-post holders, boring bars with adjustable cutters, tap and reamer holders, etc. Fig. 8, which shows the machine set up for casting work, will give some idea of the practise followed in operations on cast iron, etc.

A number of work-holding devices have been designed for this machine. In Fig. 9 is shown a patented step chuck and

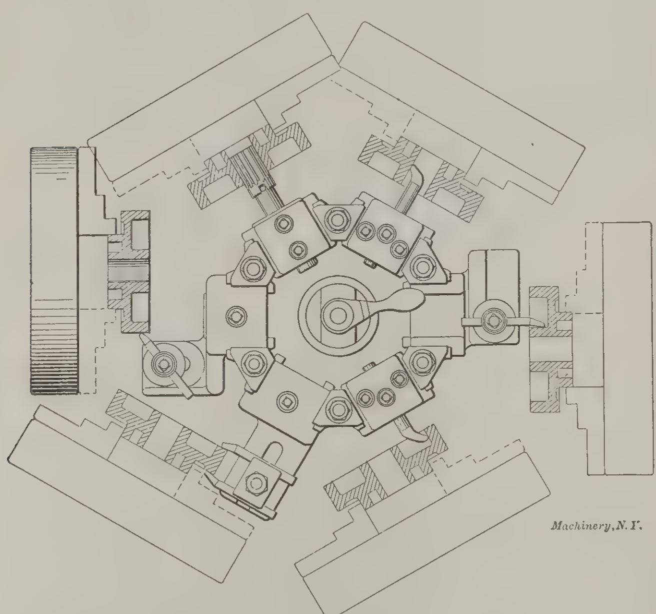


Fig. 8. Typical Layout of Operations for Finishing a Casting.

closer, with adjustable jaws. The chuck itself, *A*, is made of steel, split in four places, each section having a beveled slot. In these slots are held the four adjustable jaws *B*. In setting this device for a second operation on a piece (such as finishing a gear blank on the side previously held in the chuck) these jaws *B* are first adjusted to approximately correct position. A plug is then inserted in the hole in the center of the closer *A*, of the same diameter as that hole. Then the step chuck is closed by the mechanism at the rear of the spindle, this consisting of an eccentric operated by a wrench. The boring tool is then brought forward from the turret, and the jaws are "stepped out" to the desired diameter, which will be the same as the diameter of the finished end of the piece made in the three-jawed chuck in the first operation. The closing mechanism is then released and the plug removed. The work is inserted in the jaws, and the chuck then closed. The work will then run absolutely true, on exactly the same axis as it revolved on during the first operation; so the second operation will be exactly concentric and parallel with the first. The jaws are made of soft machinery steel, but when used up, they are easily replaced with soft steel pieces of any shape desired. The largest capacity of the chuck is 12 inches.

For centering and turning forged bolts, the heads of which may be more or less eccentric, two chucks are used; a lever scroll chuck mounted in one of the turret slots, and a forging chuck with two floating jaws, carried by a shank fitting the regular 2-inch chuck jaws in the spindle. The body of the bolt is placed in the scroll chuck on the turret, its head coming where it may. The turret is advanced by hand until the head comes between the jaws of the forging chuck, which are then closed by the right and left-hand screw, gripping the bolt head. The scroll chuck is then opened, the turret run back and indexed to the first turner required, and the turning proceeded with. These two chucks are especially recommended for use in railroad shops.

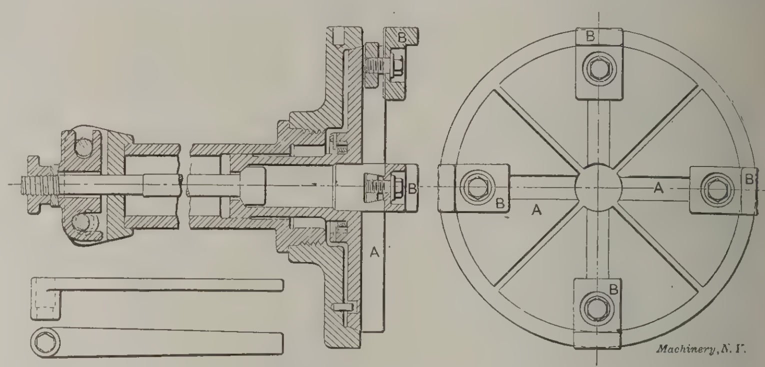
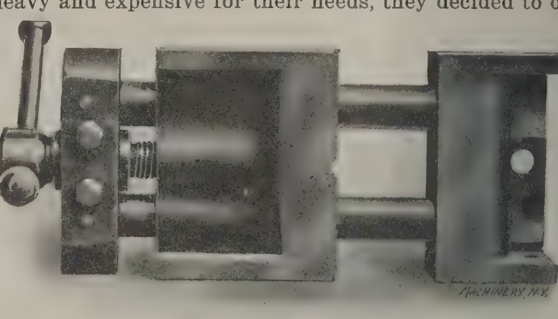


Fig. 9. Step Chuck for Second Operations.

The machine swings 19 inches over the bed and 10 inches over the forming slide. There is a 2⅝-inch hole through the spindle. The largest standard collet provided is 2 9-16-inch. The greatest length that can be turned is 26 inches. The driving pulley is 14 inches in diameter for a 3-inch belt, and sixteen feeds are obtainable with a two-speed countershaft.

THE TITUS DRILL PRESS VISE.

The Titus Machine Works, of Marion, Ohio, is building the simple and inexpensive drill press vise shown in the accompanying halftone. This tool is the outcome of the experience in manufacturing of the men who build it. They had had considerable trouble in their own shop practise in firmly holding light and irregular work for drilling, and a consequent excessive amount of breakage of drills. Having decided to remedy the difficulty by equipping the plant with some kind of vise or chuck for the purpose, and finding everything on the market too heavy and expensive for their needs, they decided to design



Drill Press Vise of Practical but Inexpensive Construction.

a tool of this kind. The vise they developed was so satisfactory to them that they have decided to manufacture it, and place it on the market.

As will be seen in the cut, the tool is remarkable for its simplicity. Its framework consists of two guide rods of tool steel (hardened so that they cannot be sprung or be injured by drilling into them) inserted at one end in the fixed jaw of the tool, and carrying at the other end the yoke in which the adjusting screw is seated. This screw is of steel, with a heavy thrust collar turned from the solid. It is threaded into a brass nut having a liberal thread surface, securely seated in the movable jaw, which slides along the guide rods and is supported by them. The jaws are 5 inches wide, 3 inches deep, and open 3 inches. They are accurately planed on all sides and one end. The movable jaw has V-grooves for holding

round pieces both vertically and horizontally. The design of this vise makes it light to handle and at the same time strong and durable. There are no blind pockets to become clogged with chips or dirt. It will sit firmly on the bottom or edge. It cannot be injured by drilling into it. In spite of these advantages, its design is such that it is remarkably inexpensive. The builders are willing to send samples to responsible firms on thirty days' trial.

EBERHARDT BROS. NO. 2-B AUTOMATIC SPUR AND BEVEL GEAR CUTTER.

The Eberhardt Bros. Machine Co., 66 Union St., Newark, N. J., is building the small-sized automatic spur and bevel gear cutter shown in the two accompanying halftones. This machine is designed for the work of which there is the largest quantity in the ordinary machine shop. It has an extreme capacity for a blank 24 inches in diameter and 6 inches face, and will cut teeth of 8 diametral pitch in steel at a good feed. This capacity includes such work as lathe and milling machine change gears, feed and adjusting spur and bevel gears, as well as other kinds of automatic milling, including the cutting of face clutches, cutters and saws, and all cylindrical or conical work of a similar nature where accuracy and rapid production are essential.

The construction follows the general design of the line of machines built by this firm, modified somewhat to suit the smaller size. Among the modifications may be noted the bevel gear drive to the cutter spindle in place of the spur gearing used on the heavier machines. The changes of speed are obtained by gears, immediately driving the bevel pinion. The cutter arbor is solid with the spindle. The cutter slide and feed mechanism are supported on an adjustable segment, which may be set at an angle by means of a worm, meshing with

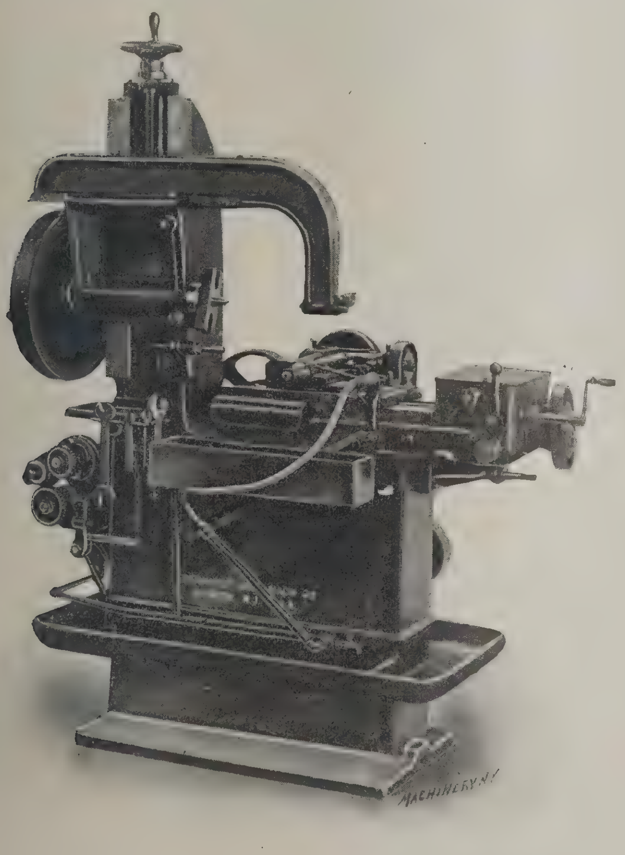


Fig. 1. Eberhardt Bros. Automatic Gear Cutter for Small and Medium Work.

teeth in its periphery. The slide can thus be tipped to any position up to 90 degrees, making the machine suitable for such work as milling face clutches, etc. In the front view in Fig. 1 will be noticed a slotted link which may be tightened to give additional stiffness to the slide, when it is set for any desired angular adjustment. The segment is graduated in degrees.

The indexing mechanism is positive, and operates through a master wheel of large diameter compared with the work, as will be seen from the cuts. An outboard support is provided for the work arbor, which is adjustable for different lengths of arbors, but is always centered accurately in line with the work spindle. This is especially convenient in a machine of this class, since it allows rapid setting. The cuts show a dog driver in place in the spindle, and a 60-degree center in the overhanging work support. These are furnished with the machine, and are useful in such work as milling flutes in taps and reamers, cutting gears on ordinary lathe mandrels, cutting pinions solid with the shaft, etc. The shank of this dog driver, like that for the various work arbors used, is drawn in to its

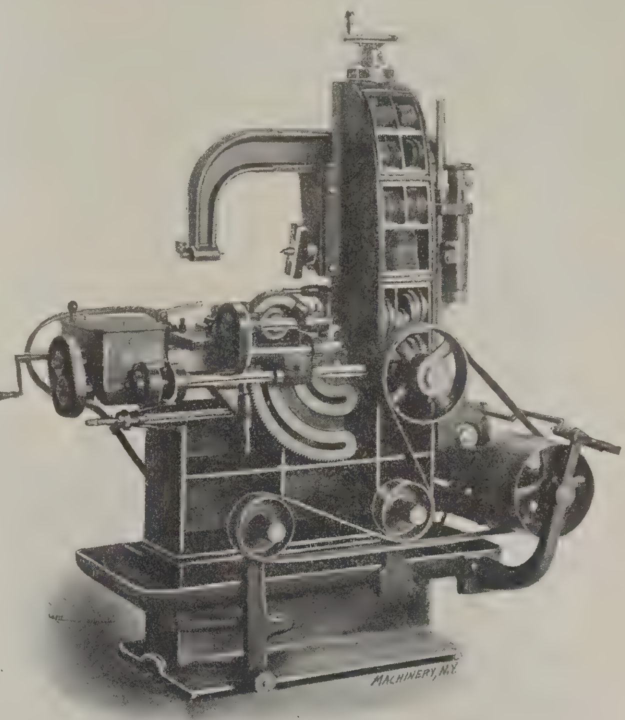


Fig. 2. Rear of Machine, showing Provisions for Cutting Bevel Gears.

tapered seat or ejected, positively, by a bolt operated with a handle at the back of the work head. The taper of the work spindle hole is No. 10.

A screw is provided for adjusting, on a lower slide, the whole feed mechanism, cutter spindle and adjustable segment, toward or away from the column, to allow for different lengths of hubs. The dial, graduated to thousandths, facilitates this setting. Graduated dials are also provided on the indexing worm and on the cutter spindle bearing, for rolling the blank and shifting the cutter in cutting bevel and miter gears. The elevating screw for the work spindle has also a dial for showing the proper depth to be cut.

The chips are caught in a box in the side of the machine, where the oil is strained from them and is caught in an ample reservoir formed around the frame. The oil pump provided affords a constant stream of cutting lubricant, and it can be adjusted to regulate the supply.

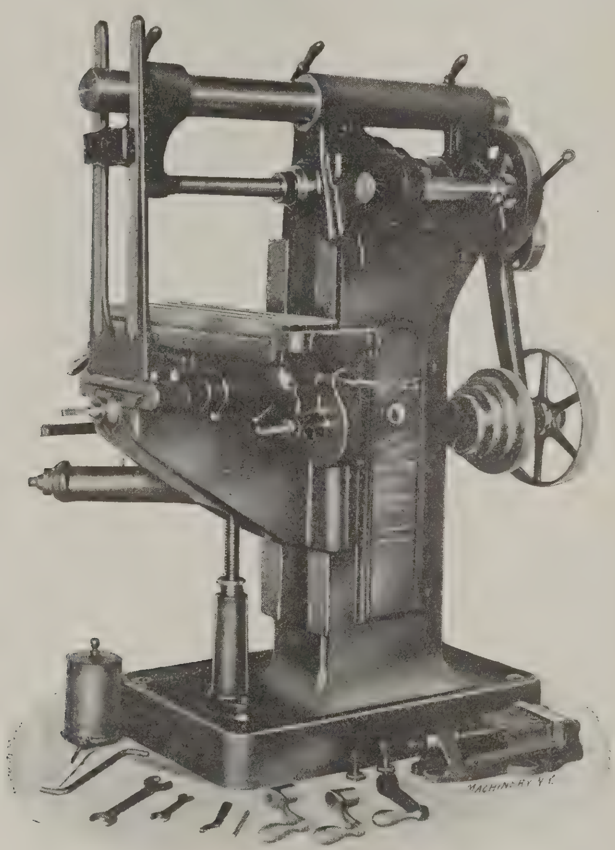
BECKER-BRAINARD PLAIN MILLING MACHINES FOR LIGHT MANUFACTURING.

The Becker-Brainard Milling Machine Co., of Hyde Park, Mass., has placed on the market two new machines adapted to meet the requirements of the manufacturer of small parts produced in large quantities—such work, for instance, as is to be found in small arms, typewriters, sewing machines, and electrical supplies. Two styles are made, one back geared and the other plain. The halftone shows the back-geared machine.

In bringing out the new model, special attention has been paid to the feed works. It is so designed as to be able to carry the full power of the feed belt, and at the same time stand up well under the rough usage to which machines engaged in manufacturing are subjected. The feed is driven by a belt from a pulley geared with the spindle of the machine, in such a way that the velocity of the belt is sufficient to drive feeds as heavy as the spindle drive will stand. The changes are obtained by a 4-step cone on the rear of the machine; the

pulleys may be interchanged so as to give a combination of eight feeds in all, ranging from 0.007 to 0.1 inch per revolution. The table is fed by a worm, meshing with a hobbed rack. The worm is driven by a worm gear of large size and a worm of coarse pitch, and correspondingly high efficiency. For disengaging the feed, a novel drop-worm mechanism is used, which obviates the difficulty met with in the old style gravity drop-worm, of clinging to the gear by friction alone. The worm is engaged and disengaged by the same lever, making the whole mechanism convenient and positive in its action. The table is also supplied with a quick return with a 4 to 1 ratio.

The new design has had the knee lengthened to permit the use of a front bracing of rigid construction, and still give the same range of cross adjustment as furnished with the older style machines. This bracing is of interesting design, being in the form of a single casting, clamped to the knee slide. To the arbor support yoke is fastened a clamp, so shaped as to permit it to swivel around its center, allowing the brace to



Milling Machine for Light Manufacturing.

be removed without entirely unscrewing any bolts at this point. This clamp is made fast to the brace by friction, giving a more rigid hold than the old style bolt, washer and slot arrangement, and at the same time allowing a much stiffer brace. The overhanging arm, which is a solid steel bar, is adjustable lengthwise, and the arbor support may be clamped on it at any convenient point.

These machines are equipped with a rigid box knee and with a telescopic elevating screw. The base has been designed along the same lines as the other Becker-Brainard millers, being heavy enough to absorb the vibration produced by the working of the cutters. The spindle cone and back gears are also of the firm's usual construction, the spindle bearing being cylindrical in form, with the wear taken up by concentric compensating bronze boxes. New patterns throughout have been made, and advantage has been taken of this opportunity to give the machine a neat and symmetrical appearance. All corners have been rounded and careful attention given to outlines, as may be seen in the cut.

These machines have a longitudinal feed of 34 inches, a cross-feed of 8 inches, and a vertical adjustment of 18 inches. The net weight is 1,650 pounds.

DOWNING UNIVERSAL BORING TOOL.

The tool shown in the accompanying line cuts is manufactured in three sizes by the Waco Machinery and Supply Co., Waco, Texas. It is interesting from the great completeness of adjustment provided by the design, permitting almost every condition of work to be satisfactorily performed. Bars of different sizes may be used for different sized holes; the extended length of the bar may be altered to agree with the depth of the hole; the point of the tool may be raised or lowered to bring it on the center line of the lathe; and even the top rake of the cutter may be changed to suit the material being worked on. These various adjustments are simply effected, as will be evident from the line cuts and the following description of the device.

Clamp *C*, which bears a general resemblance to a lathe dog, is provided with a T-head which enters the T-slot of the slide-

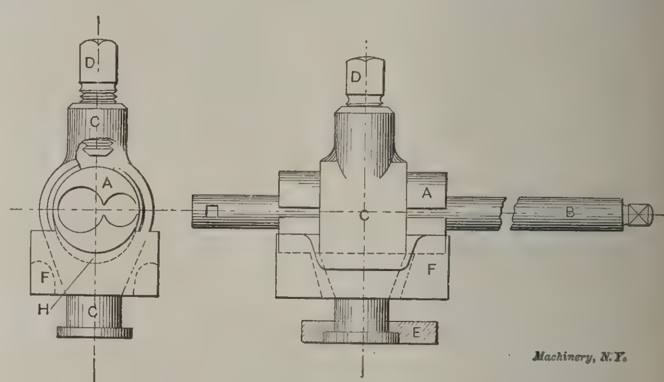


Fig. 1. Boring Tool and Holder, providing for Numerous Adjustments.

rest. A shoe, *E*, is furnished with the tool, which may be finished to fit the slot of any given lathe, thus making alterations in the clamp *C* unnecessary. Block *F* rests on the upper surface of the slide-rest, and has a hole through its center allowing clamp *C* to be passed through it. A bushing *A*, adapted to carry a boring bar of the desired size, passes through the opening in clamp *C*, and rests in a cylindrical seat in the top of block *F*. The lower side of the opening in the clamp is relieved as shown at *H*, so that when a boring bar, such as *B*, is in place in the bushing, and setscrew *D* is tightened down, the whole structure is clamped firmly together and to the slide-rest.

Bushings *A*, of which there are three, as shown in Fig. 2, have each two sizes of holes in them, so that boring bars of six different diameters are provided for. In the tool shown, these diameters are ¼, ½, ¾, 1, 1¼ and 1½ inch. The bar itself is shown at *B*. It is provided with two slots for holding the cutter, either at *L*, as shown by the full lines, or at *N*, as shown by the dotted lines. One position is useful in boring a

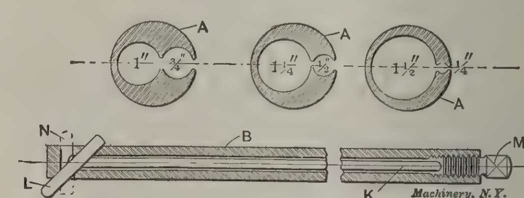


Fig. 2. Details of Boring Bar and Bushings.

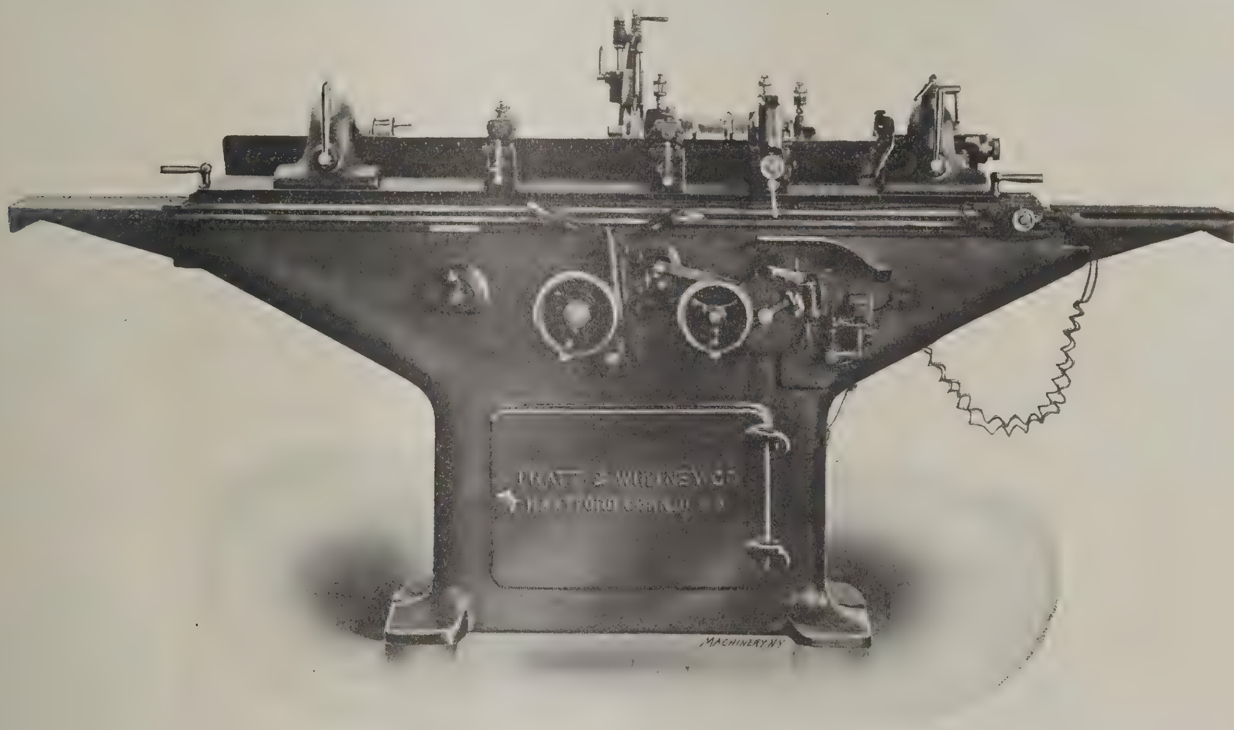
blind hole, while the other is better suited for cases where there is clearance at the end of the cut. As shown, the bar is hollow. A setscrew, *M*, bearing on the end of rod *K*, clamps the blade firmly in its seat.

The manner of making the various adjustments described can now be readily followed. Any of the various sized bars furnished can be raised or lowered to the height of the center line of the lathe, by rocking in its seat, in block *F*, the bushing in which it is mounted. The bar may be adjusted for depth of hole by projecting it more or less from the bushing in which it is clamped. The top rake of the blade may be altered for different materials by rocking the bar in the hole of the bushing in which it is mounted to give an acute angle for babbitt, for instance, and a radial cut for brass.

THE PRATT & WHITNEY AUTOMATIC GRINDING MACHINE.

The Pratt & Whitney Co., of Hartford, Conn., has designed and is marketing an automatic grinding machine, for cylindrical work up to 5 inches in diameter and 48 inches long. The word "automatic" can be applied to this grinder in a new sense. It does not mean simply the continuous reciprocation of the work table through a range determined by adjustment of the stops, and the provision for mechanically feeding in the emery wheel a definite amount at each stroke. Besides these usual provisions, this grinding machine has the novel feature of an automatic sizing attachment, which has been developed to such a point of practicality and efficiency that, as the builders say, "for the first time accurate grinding may be put into the hands of unskilled labor."

This remarkable function is performed electrically. An arm which rests upon the work being ground is set, with a micrometer screw, to make an electrical contact, when the work is down to the desired size. It does not matter how much the emery wheel wears, as the machine will keep on feeding until this electrical contact is obtained. At the first contact, the feed will switch off from coarse feed to fine feed. At the second contact, it will throw off the feed altogether.



Grinding Machine with Automatic Feed and Electrical Sizing Attachments.

Thus it will be seen that work can be reduced very rapidly, as the feed can be adjusted to the limit that the work will stand, until the size has been nearly obtained, whereupon the machine automatically changes to a very fine feed, thus giving the work a smooth finish and exact size. If it is desired to grind only one or two pieces, where the setting of the sizing device would not pay in the opinion of the operator, the machine may be operated in the usual manner.

As to the general features of the machine, aside from the special improvement just described, the tool is a universal grinding machine of ingenious and practical design, and careful workmanship. The traverse of the table is operated by a rack and pinion, from a reversing mechanism driven by positive hardened clutches. The machine will reverse to within 0.001 inch, thereby making it possible to grind close to a shoulder. To facilitate changing the traverse speed of the table, as is often necessary, a feed changing mechanism giving three rates has been provided, changeable while the machine is in operation. It is operated by a crank handle at the front of the machine, shown in the cut at the left of the table traverse hand-wheel. The head and foot block are of very heavy construction. The pulley for rotating the work has dust-proof bearings. The machine is provided with two back rests of the most improved type, arranged (as are also the head- and foot-stock) to allow the use of convenient water guards for wet grinding. The water pump is of a new type, idlers for guiding the belt being dispensed with. A micrometer adjustment is provided for grinding tapers. This is so designed that it may be set by any one who can understand the reading of a micrometer caliper. If, for example, a taper of 1/8 inch per foot is desired, the micrometer will be turned 125 graduations.

The emery wheel is carried by a hardened and ground tool steel spindle, running in adjustable self aligning bronze boxes, mounted on a cross slide heavy enough to absorb all vibration. The weight is applied to the slide in such a way as to keep it constantly pressing hard against the feed screw, thus preventing the wheel from feeding forward except through the screw. The bed is cast in one piece and has a three-point bearing on the floor. All gearing and bearings are well protected from the dust, though so designed as to be accessible for examination and repairs.

NO. 4 LA POINTE BROACHING MACHINE.

The necessities of the automobile builder have resulted in a great increase in the amount and variety of work done by the broaching process. The use of squared shafts in the transmission case, and the general avoidance of keys and key-ways throughout the mechanism, result in having many parts formed with holes of other than circular section. Holes of this sort may be finished in various ways; they may be filed out tediously by hand to suitable gages, they may be finished on the slotting machine, or (the most rapid way of all) they may be "broached" at one stroke, with machinery and tools suitable for the purpose. The process of broaching consists in pulling through the opening to be formed a long blade having a series of teeth with the outline of the original hole at the inner end, gradually increasing in size and changing in shape until they have the outline of the completed hole at the further end. As such a tool as this is pulled through the work, each tooth removes a little metal, and the successive cuts thus taken complete the work as designed.

A machine much used for this purpose is the broaching machine built by the La Pointe Machine Tool Co. of Hudson, Mass. A great many of these are in daily operation, especially for wholesale key-way cutting. The same firm has recently extended its line of broaching machines to include a new No. 4 size, intended for longer and heavier work than their older machines. This tool is shown in Fig. 1. The broaching tool (used for simple key-seating in this case) is seen projecting from the front face of the machine. The

inner end or shank of this tool is grasped in a cross-head, sliding in the long guides extending forward from the head-stock. A slow inward cutting stroke can be given to this cross-head by means of the heavy screw shown connected to

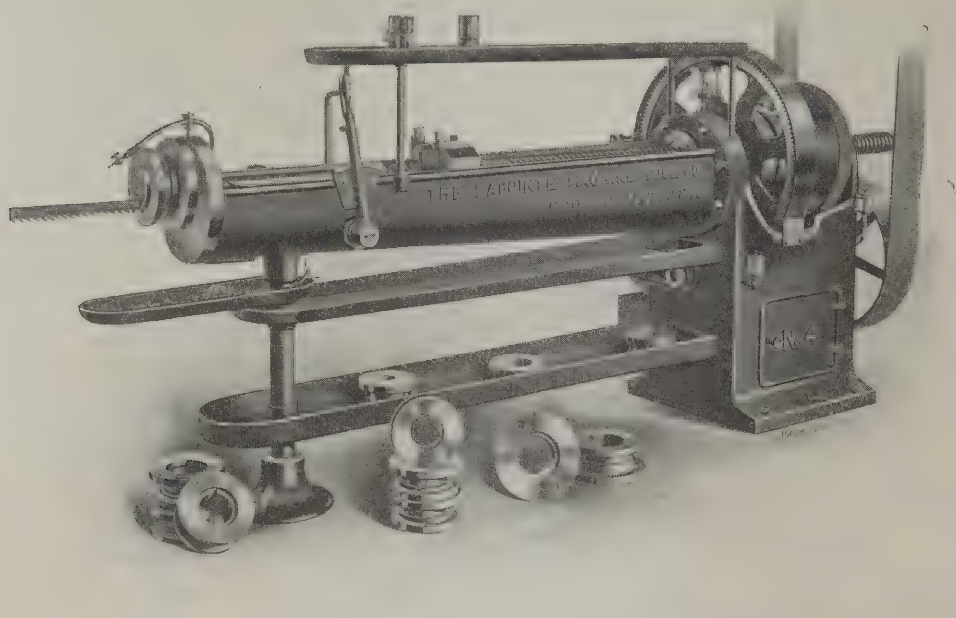


Fig. 1. Heavy Broaching Machine, especially adapted to Automobile Work.

it. This screw is threaded through a phosphor-bronze nut about 13 inches long, located between a driving gear and a friction pulley. The driving gear is rotated slowly with a speed reduction of 10 to 1, while the friction pulley has a rapid motion given to it. A clutch keyed to the bronze nut may be engaged with either the gear or the pulley, so that either a slow inward movement for the cutting stroke, or a rapid transverse in the other direction for a quick return, may be given to the head and its attached broach or cutter bar. This clutch is operated by the lever shown near the working end of the machine. Automatic stops are provided for the forward and backward motion of the head, the total travel of which is 70 inches. When the lever is in a vertical position, the clutch is entirely disengaged and the head and cutter bar are stationary. This mechanism is similar to that employed in the smaller machines previously referred to.

For cutting key-ways (the operation for which the tool is shown set up in Fig. 1), the cutter bar is run clear out and the work put on over it, and seated against the face-plate shown. This face-plate has a boss which fits the bore of the work to be key-seated, thus locating it with reference to the cutter bar. The machine is now started up for the cutting

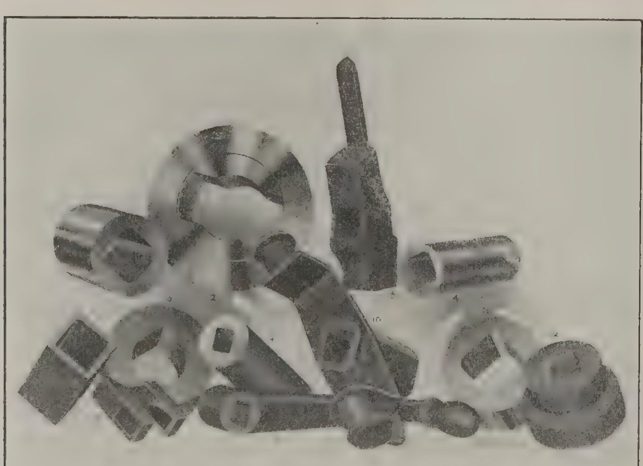


Fig. 2. Work Performed by the La Pointe Broaching Machine.

stroke. The teeth of the broach come in contact with the work one after the other, taking successively deeper cuts until the key-way is finished. For such work as square and oblong holes, etc., a clearance hole as large as possible has first to be drilled. The work is then put on the face-plate and the shank of the broach pushed through the clearance hole of the work, and grasped by the traveling head of the machine. The pulling through of the broach by the head completes the hole at one stroke. As before mentioned, it is not necessary to remove the cutter bar from the machine each time in the case of key-ways as it is with square holes, and several pieces may be finished at a time.

Some examples of work done on this line of machines are shown in Fig. 2. Piece No. 1, having a 1½ inch square hole 3 inches long, was broached on a No. 3 machine with two operations in six minutes. Piece No. 2, made from a steel casting with ⅛-inch stock all around in the cored hole, was finished at one stroke. The square holes in the gun chamber, No. 3, the wrench jaw, No. 7, the crank handle, No. 8, and the universal joint jaw, No. 10, were performed in from two to five minutes, the longest time being taken by piece No. 3. Piece No. 4, having a 1¼ inch square hole 5 inches long, was finished with three broaches in ten minutes. Part No. 11 was broached on a No. 3 machine at one stroke. The hole is 1¾ inch square and 1¾ inch long. Part No. 12 was broached in six minutes with two operations on a No. 3 machine. The hole is 1½ inch square and 2½ inches long.

The capacity of the No. 4 machine, shown in Fig. 1, is a 3-inch square hole 8 inches long, or a 1¼-inch key-way 14 inches long. In the cut this machine is shown broaching a ½-inch key-way 5 inches long in a steel clutch. The time required for this was one minute.

YOST ELECTRICALLY-DRIVEN BENCH DRILL.

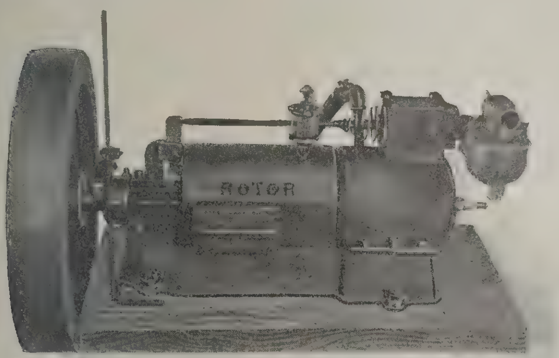
The little drill press shown in the cut is about as neat an arrangement for the purpose as could well be imagined. As shown, the motor is mounted directly above the spindle so that the armature drives the spindle itself, without the intermediation of gearing or belts. The spindle and sleeve are absolutely dust-proof. The thrust of the motor is taken by a ball bearing, and the shaft and spindle are hardened. The feed is very sensitive, and there is no vibration due to flying belts and unbalanced pulleys.

Yost Bench Drill.

The motor gives a variation in speed from 800 to 3,000 revolutions per minute in 24 steps, thus enabling the operator to use the proper rate for all sizes of drills from 0 to ¼ inch. The motor is of the slow speed type, thoroughly ventilated; it can be brought instantly to any speed, stopped or started, without the inconvenience of shifting belts or friction gears. The capacity of the machine is for work up to 10 inches in diameter for a ¼-inch drill. The travel of the spindle is 2¾ inches. The motor is arranged to be directly connected to a 110- or 220-volt lighting circuit by the ordinary lamp socket. The whole outfit can be easily and quickly moved from one part of the shop to the other. The machine is built by the Faure Electrical Works, of Ossining, N. Y.

NOVEL TYPE OF GAS ENGINE.

The "Rotor" gas engine, made by the Central Machine & Metal Co., Moline, Ill., is built on a plan which, according to its builders, gives it distinct advantages over the ordinary connecting-rod and crank-driven engine. The machine shown in the cut is of the 5-horse-power size. The compactness of the design will be realized when it is stated that the base is 9 inches wide by 19 inches long, and that the total height of the engine is only 11 inches. The main peculiarity of the engine is the method used to convert the reciprocating motion



The Rotor Gas Engine.

of the piston into the rotary motion of the shaft. This is accomplished by a means that gives a nearly frictionless movement, all journals being of the roller or ball-bearing type. The construction may be extended to any desired number of cylinders, all in compact horizontal form. It has no geared parts, although it is of the four-cycle type. It may be readily reversed. Its small requirements as to floor space, and the direct power connections, with the tendency of the vibrating motion to be always lengthwise of the engine, give the "Rotor" engine design decided advantages for boat and automobile use.

Among the other claims made by the manufacturers for this engine are, a gain due to the directness with which the power is applied to the shaft, a low fuel consumption, a quick air compression, and a thorough scavenging of the cylinder. Patents for this engine have been applied for.

FRANKLIN AIR COMPRESSORS.

The accompanying half-tone shows an air compressor built by the Chicago Pneumatic Tool Co., at their compressor works at Franklin, Pa. This machine is one of two installed in the power plant of the new South Altoona foundry of the Pennsylvania R. R. The machine is of the cross compound, two-stage air cylinder type, with separate intercoolers (not shown), and mechanically moved intake valves. The steam cylinders are 12 and 21 inches in diameter. The air cylinders are 11 and 19 inches respectively, with 24-inch stroke, designed for 100 pounds terminal air pressure with 125 pounds steam pressure. The machine has a piston displacement of 985 cubic feet of free air per minute, when making 125 turns per minute.

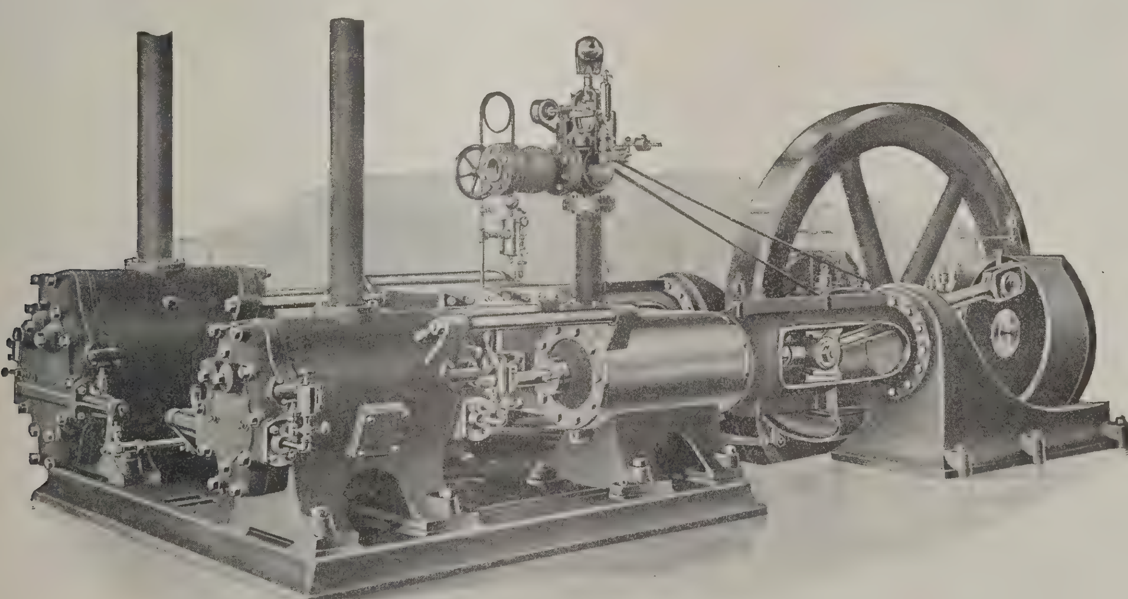
The frame of the machine is strongly built, following the approved lines of heavy Corliss engines. The air cylinders are tied to the steam cylinders by large tie-rods above and a heavy sole plate below, to which latter all four cylinders are fastened, as shown. The pillow blocks have unusually broad pedestals.

The air cylinders and cylinder heads are water-jacketed. The cooling effect is especially concentrated around the discharge valves, which naturally sustain the heat, due to the compression and friction, that has not been eliminated by the cylinder water jacket during the actual process of compression. To exclude the possibility of serious accident from the water which would enter the interior of the cylinder should the gasket between the cylinder and the head become damaged, an outside water connection is used for leading the water between the cylinder and the cylinder head. The steam valves are balanced slide valves, designed to give the greatest possible economy. In the machine shown the air intake valves are of the Corliss type, positively operated.

The cross-head, connecting-rod ends, bearings, etc., are built to agree with the most advanced steam engine practise. The shaft and crank-pins are forced to their places, the former being keyed and the latter riveted. The crank-pins are of special ground steel, while the crank-shafts are made from high grade steel forgings accurately turned and finished. The connecting-rods are of steel forgings finished all over, with adjustable boxes.

An intercooler, separate from the compressor so that it may be placed where convenience dictates, is a most important feature. It is of improved construction, allowing the interior to be cleaned readily. The tubes are made of a composition metal which does not rust or become foul. It is so constructed that the tubes are free to expand and contract without buckling and leaking.

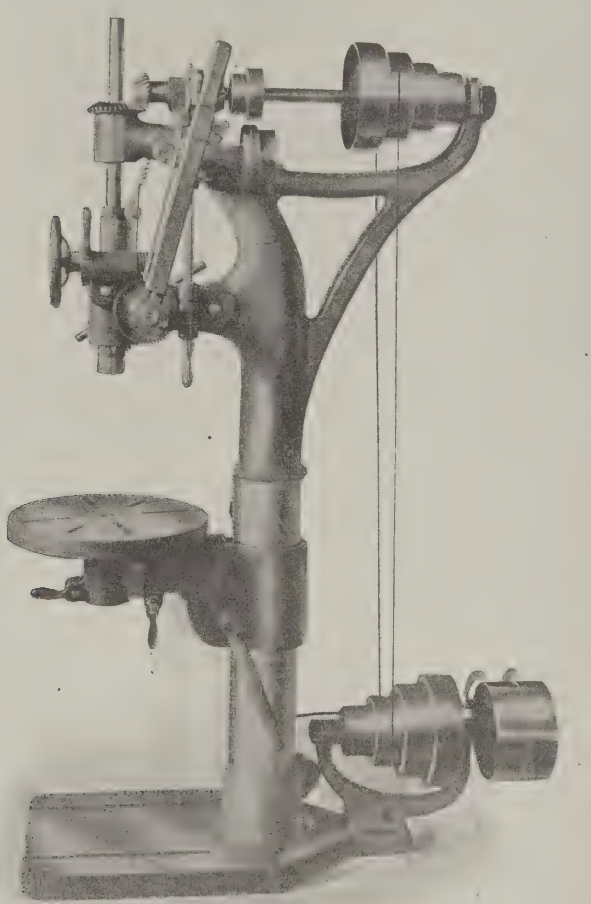
Each compressor built by the Chicago Pneumatic Tool Co. undergoes before shipment a thorough working test. A special level testing floor of 15-inch I-beams is provided for this purpose in the Franklin plant. Even the largest compressors may be tried out at extreme load and maximum speed. All steam and air cylinders have indicator connections, and diagrams are taken under exact working conditions. These cards must show an efficiency equal to the established standard of the plant. A capacity test is also made to determine the actual



Franklin Air Compressors, built for the Altoona Shops of the Pennsylvania Railroad.

volume of compressed air delivered. Records of these tests are carefully filed and are always available for reference. A complete equipment of jigs and fixtures is provided for manufacturing these compressors, insuring absolute interchangeability, so that duplicate parts, whenever needed, may be sent for with full confidence that they will fit in their place.

The Chicago Pneumatic Tool Co. manufactures these Franklin air compressors in more than 100 sizes and styles, ranging



Robertson Drill Press with Universal Table.

in capacity from 30 to 5,000 cubic feet of free air per minute displacement, and suitable for a wide range of uses in addition to the operation of pneumatic shop appliances. Full information may be obtained from the company's offices in Chicago or New York, or from its branch offices in other cities.

NO. 21 ROBERTSON UNIVERSAL DRILL PRESS.

One of the important features of the drill press manufactured by the Robertson Mfg. Co., Buffalo, N. Y., is the universal adjustment given to the drill table. As may be seen in the cut, the table can be rotated about a horizontal axis, thus making it possible to drill a hole at any angle with the surface by which the work is fastened down. The value of this feature has been demonstrated continuously in the plant of the builders in the past few years. It was originally designed to perform certain operations in their product, and proved to be such a success that they have decided to build a complete line of drill presses with this feature. Their long experience with it enables them to present it in practical form.

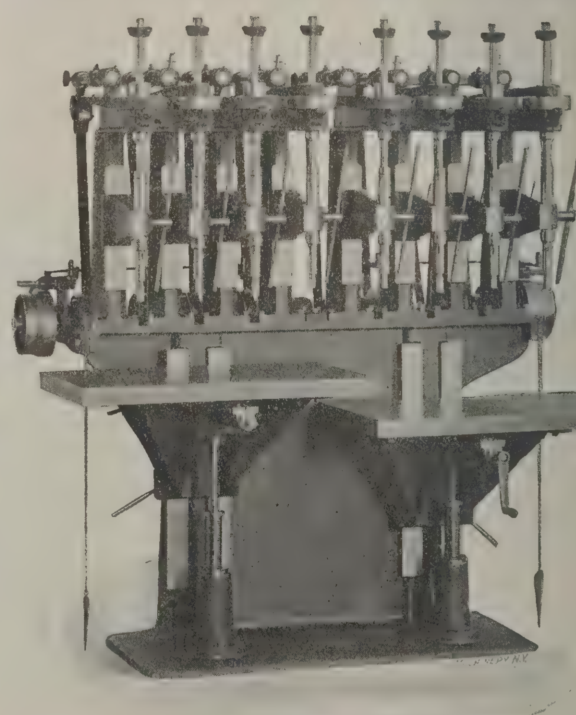
The knee is raised by a crank fitted to a steel shaft, with a pinion milled from the solid, meshing with a rack on the column. The rack is also of steel, with cut teeth. The universal joint for the work table is so designed as to give a rigid support to the table, with provision for drawing all bearings tightly together with the clamp screws shown. A lock bolt is provided for setting the table accurately in 45 and 90 degree positions. The spindle is of special high carbon steel, carefully fitted, with the thrust taken by fiber collars. The hole is a No. 3 Morse taper. The column is heavy and secured to the base by a clamping bolt. The base is provided with T-slots for clamping heavy work.

The machine may be provided in any of the following forms: With universal table or solid knee; with lever feed; with wheel and lever feed and quick return; wheel and lever feed, quick return, power feed, and automatic stop; it may also be furnished with or without back gears as desired. The bevel gears are planed from the solid metal and are provided with guards. The machine shown will drill to the center of a 42-inch circle.

1907 MODEL HENRY & WRIGHT DRILL PRESS.

The ingenious sensitive drill press invented by Mr. Chas. D. Rice, and built by the Henry & Wright Mfg. Co. of Hartford, Conn., was described in the November, 1904, issue of MACHINERY. As will be remembered, a number of novel ideas were incorporated in the design of this machine. Four speeds, for instance, are obtained from two-step pulleys. The machine is equipped with ball-bearings throughout, even for the loose pulley; a roller key arrangement is used to transmit the rotary motion from the spindle pulley to the spindle; and this pulley is supported entirely independently of the spindle, on ball bearings. The result of these various refinements is a machine as sensitive as the smallest, and yet able to drive with ease a ¾-inch drill with unusually small belts.

In the new model machine, of which an example is shown below, further improvements have been introduced to increase the efficiency of the drive and the handiness of operation. An entirely new spindle pulley construction has been used, which insures perfect alignment and confines the wear to the ball cases and the cones alone. When this spindle pulley is assembled with the driving blocks, ball cases, cones and balls, it may be handled as a complete unit, and may be placed in position in the frame, or removed at will by adjusting two screws in the bearing, provided for that purpose. The pillars in the new model have been enlarged, and are tapered from the top to the base to allow the use of a heavier weight for the quick return. The new shipper shown brings the handle to the nearest practicable point for the operator; the long multiple spindle drills are furnished with handles on both sides of the machine. By referring to the



Henry & Wright Ball-bearing Multiple Spindle Drill.

previous description, above referred to, it will be noted that one of the idlers is raised or lowered to shift the belt from one step to the other on the spindle pulley. In the new design this change is made by a bayonet catch, instead of by the thumb-screw formerly used. The weight of the castings throughout the machine has been increased to give greater rigidity, and all the spindles are furnished with 1⅛-inch noses to give greater strength to spindle when large drills are used.

The new model is made with from one to eight spindles, and

of from 7 to 15 inches overhang, so as to drill, if desired, to the center of a 30-inch circle. In the eight-spindle machine, as shown in the cut, the base is made in box form, to give the greater rigidity required in a machine of this character. Two tables are also provided, each with a heavy telescopic raising screw. This duplication of tables and raising screws allows the operator to work to advantage with oblong jigs. One of the tables may be raised to the proper height to support the jig when it is laid on its side, while the others may be adjusted to drill into the jig from the end. This machine also is provided with a separate tight and loose pulley for each of the spindles, so that eight speeds may be obtained, each suitable for the work it has to do. A small two-piece pulley may be clamped to the rear shaft, to give the proper speed for tapping.

THE WING STEAM-TURBINE-DRIVEN FAN.

Mr. L. J. Wing, president of the L. J. Wing Mfg. Co. of 90 West St., New York City, who is said to be the original inventor of the disk fan, has recently developed a novel combination of disk fan and steam turbine which is adaptable for a number of uses.

The construction, as may be imagined, is extremely simple. A rim is carried around the ends of the blades of a suitably designed disk fan; tying them together and being supported by them. To this rim is fastened a set of carefully designed turbine buckets, against which jets of steam are directed from two or more suitably disposed nozzles. There is but one rotating shaft, and practically but one rotating member, the turbine, buckets, rim, fan and its shaft all revolving as one piece in double ball-bearings.

The design of the nozzles, buckets and fan, has been the subject of careful study and experiment, and a high degree of efficiency has been attained. The simplicity of the arrangement will be at once appreciated when a fan of this kind is compared with one of the same capacity driven by a steam engine, mounted in a suitable housing and supported on the required foundations. No exhaust piping is required, since the steam after imparting its energy to the wheel passes along with the delivered air. The only attention or care required is the lubrication of the ball bearings, once a month or thereabouts, with vaseline or other suitable compound.

A use for which this outfit is especially adapted is in producing forced draft for boilers. For this work it is usually set into the side or rear wall of the boiler just below the grates. Such an arrangement has all the advantages of simplicity, low first cost, and ease of maintenance.

A TIME AND COST COMPUTER.

At the Railway Master Mechanics' Convention at Atlantic City, the Bullard Machine Tool Co. distributed to the members an ingenious and very useful souvenir in the form of a time and cost computer. This is a circular slide rule, designed by Mr. William Cox, of New York, who has had considerable experience in this line. It consists of cardboard sectors which may be revolved about a central pivot to bring the various graduations on the peripheries in line with each other. By following the directions given, various problems relating to time and cost may be solved, such as the following: To find the time required for turning or boring when the cutting speed, feed, diameter of work and length of cut are known; to find the approximate time required for facing when the diameter, length of cut, cutting speed and feed are known; to find suitable cutting speed and feed when the dimensions of the piece are known, and the time required has been fixed. To find the cost when the rate per hour and time to do the work are known. The instrument and the directions are enclosed in a handsome leather case which fits the pocket.

* * *

Eggs are ordinarily regarded as very fragile, but proportionately to its weight an egg shell is very strong. The "egg test" so much used in trying elevator safety stops is, therefore, deceiving. An egg may not break when subjected to the stopping test in an elevator with an impact that would be disastrous to a human being, and which, in fact, might break nearly every bone in his body.

INDUSTRIAL NOTES FROM EUROPE.

BRITISH TRADE TOPICS.

The trend of British industrial development is still upward. Considerable efforts have been made during the last few years to have the fiscal system of the country—practically universal free trade—altered in such manner as to have a protective effect on certain industries; but these efforts have shown but little practical result. The current Board of Trade returns indicate such an enormous volume of trade that hesitation is naturally shown to interference with methods so remarkably successful. For instance, the imports into Great Britain during the month of April represent a total value of $283,930,485, an increase of $48,633,935 over the figures for the corresponding period in last year, and the exports were valued at $172,084,330, and are $36,922,800 in advance of the total for April, 1906. For the first four months of the present year the imports were valued at $1,139,805,460, an improvement of $133,419,270, and the exports for the same term with a total of $681,419,260 were $90,272,250 ahead of last year's corresponding returns. The manufacture of iron and steel stood at $20,493,155, an increase during the month under consideration of $5,121,515. Machinery comes fourth among the classified exports with $13,096,010, an increase of $2,330,915. Textile machinery was imported to the value of $90,470 during the month. This was nearly $50,000 in advance of the same period last year. The exports of this class of machinery during April were $3,142,465, as against $2,639,640 in the corresponding portion of 1906.

A specific instance of the effect of free trade is in evidence in the case of the silk and felt hat industry, which is enjoying a period of unexampled prosperity due to the manufacturers obtaining their raw material distinctly cheaper than any of their competitors. This activity is, of course, reflected to some degree on the machinists, catering specially to this industry.

The Shipbuilding Industry.

Prices of materials for engineering industries remain very stiff. All British brands of pig iron are in great demand both on home and export account. Shipbuilding on the northeast coast and the Clyde has received an impetus during the last month or so in the way of additional orders, though conditions were not at all unfavorable previously. Messrs. Yarrow & Co., Ltd., the well-known torpedo-boat builders, who are removing from the Thames to escape the unfavorable local conditions, are having new works erected at Glasgow by Sir Wm. Arrol & Co. The present portion now under erection has a length of 248 feet, and three bays of an aggregate width of 153 feet. The boiler shop is 303 feet long with three bays totaling 153 feet wide. Adjoining, the same builders are putting up workshops for the Coventry Ordnance Works, Ltd. Both have a length of 675 feet and a total width of 134 feet, the height being 63 feet. Considerable interest is being evinced in the manufacture of motor boats, which are now built for quite a variety of commercial inland and coasting services, in addition to the pleasure types of craft, which were at first mostly considered.

Federations and Unions.

Federation of kindred groups of trade, is becoming increasingly in evidence on the part of both employers and workmen. The latest instance is in the case of the operative iron and brass founders, where a number of sectional trade unions have arrived at a common understanding, and are formulating governing regulations. These societies include molding machine hands, brass founders, coremakers, etc., as well as the orthodox iron molders. On the northeast coast discussion is proceeding as to the organization of the plating squads employed in the steel shipbuilding trade. It is claimed by the employers that the basis of demarkation of work among the men is out of touch with modern requirements, and gives an advantage to other competing districts, which work under more flexible conditions.

In the automobile industry steps are being taken to standardize specifications of material and generally used details, and to lay down a common basis on many points which, more

or less loosely defined, militate against cheap production. Considerable attention is also being given to the training of junior aspirants to membership of the institution specially concerned with this branch of engineering, special facilities being provided for this purpose.

Building and Civil Engineering.

The recent Building Trades Exhibition at Olympia, London, was very successful and demonstrated the increasing interdependence of the building and engineering trades. Methods used in British building practice are being considerably influenced by American ideas of preparing concrete, asphalt, etc., by machinery, which is obtaining an increasing hold.

An indirect result of the carrying out by British contractors in Egypt of important civil engineering works, is the training thereby afforded to large numbers of natives. The bulk of the labor employed has been local, and it has been found that under the supervision of British instructors and foremen the natives have done very creditable work. This feature has been specially marked in the case of the erection of steel structures.

Gas Engines.

On behalf of the Institute of Mechanical Engineers, Prof. Burstall, of Birmingham University, is conducting a series of tests and experiments on the thermal efficiency of gas engines. It is understood that some remarkable results have been obtained, and the publication of the general conclusions arrived at, in a special report to the Institute, is anticipated with considerable interest by gas engine builders and engineers generally. Gas engines, in what were not long ago considered as unwieldy sizes and powers, are coming into increasing use. Their employment varies from blast furnace and steel works duty to the running of cotton mills and vessels for inland traffic. Several concerns which build large steam engines, turbines, etc., now manufacture gas engines also. Among these may be mentioned Mather & Platt, Ltd., and the British Westinghouse Co., Manchester. Messrs. Beardmore & Co., Ltd., Glasgow, also build large gas engines to work with blast furnace gases.

Shop Topics—Machine Tools.

Machine men—those working drills, planers, milling and gear cutting, and grinding machines, etc.—are becoming better recognized in this country than formerly. To obtain really good results from modern machines, on a profitable interchangeable basis, requires in many instances high skill, and in others such consistent carefulness and application, that employers find it expedient more frankly to appreciate—in the direction of the pay box—such services; while the easily identified types of skilled engineer journeymen find their work and that of the machine men more closely merged than ever before. When advertising, too, much has sometimes been made of the "automatic" characteristics of their machines by builders, with the result that neither the tools nor the men manipulating them have received their due meed of respect. Though machine tools to a very considerably value have during the last number of years been imported from America by Great Britain, the reciprocal process has been on a comparatively small scale, though on the Pacific coast the heavier British tools appear more in evidence than in other sections of the United States. This state of things is probably due, to a great extent, to the heavy duties exacted on machinery entering the United States. There are signs, however, of some little change of attitude, as we have heard during the last year or two of a very fair number of British tools being sold on American account. There is little doubt that the duties tend to establish a greater degree of insularity on the part of Americans than even the Britishers have in the past been credited—or charged—with. Over here machine tools of British, American, and Continental origin work cheek by jowl, and a broader and less partial estimate of their relative merits can be made than in perhaps any other country. In conjunction with the above mentioned tendency, the fact must also be taken into consideration that British importers of machine tools are increasingly manufacturing tools on their own account, either in their own workshops or by contracting with other British shops. The manufacture of accessories of small and medium dimensions has also greatly increased in the last few years. The introduction of high-speed steel, which after being introduced to Europe from America at the Paris Exposition of 1900, has since mainly been manufactured here, has largely contributed to this position. High-speed twist drills, in particular, are manufactured by a surprisingly large number of concerns, who, though not much in evidence in the technical press, contrive to do a very respectable business. Though the American output may be larger than ever, it is evident that transatlantic producers have missed this development. Several details of machine tool construction appear to be rapidly becoming less prominently identified with British or American practise respectively. Such instances as lathes having flat grinding surfaces, or raised V-s on the ways of the bed, gap lathe beds—fixed or adjustable—single or 4-stud lathe tool holders, friction-driven countershafts, etc., which were formerly quite distinctive features, cannot now, in themselves, be taken to indicate the origin of a machine tool. This interchange is probably "all to the good."

Henry Pels, Strand, London, has within the last five or six years introduced a number of punching and shearing machines of Continental origin into this country. They are mainly intended for use on constructional steel work, and vary from hand-worked machines to motor-driven examples of considerable power. Their main features are that the framing of all the types is built up of mild steel plates riveted together, so that a machine for any standard or special duty can be quickly made up without the necessity of pattern making, and that the stroke of the tools is produced by cam movements worked by ratchets, the movements being extremely small but rapid. The hand-worked machines cover a surpisingly large range of work. In this country Geo. Richards & Co., Ltd., Broadheath, have largely identified themselves with the open side, or traveling tool, type of metal planing machines, and have recently produced several machines for special applications of the feature. In one, the overhanging arm carrying the tool box can be inclined at an angle for planing diagonally. In another the ordinary arm can be removed and a vertical one substituted. We hope later to give some further details and illustrations of these machines. JAMES VOSE.

Manchester, England, June 1, 1907.

MISCELLANEOUS FOREIGN NOTES.

ANDREW BARCLAY, SONS, & CO., LTD., Kilmarnock, Scotland, builders of locomotives and railway motor cars of all types, being one of the two leading firms in Scotland in this industry, have recently completed considerable extensions to their works.

EXPOSITION OF SAFETY DEVICES IN BUDAPEST.—According to *Industritidningen Norden*, there will be held at Budapest, during the months of August, September and October this year, an international exposition for safety devices. Inquiries regarding this exposition should be addressed to the Bureau of the Exposition, Balvamyutca 2, Budapest, Hungary.

MACHINE TOOL OUTLOOK IN SPAIN.—Consular reports from Spain indicate that the demand for high-class American machine tools is steadily increasing in that country. Although there are no exact statistics, it is likely that at least $200,000 worth of these tools were exported to Spain from the United States during 1906. The automobile industry is prosperous and growing in Spain, and machines for automobile manufacturing are in demand.

MACHINE TOOLS IN TURKEY.—Consul Ernest L. Harris, of Smyrna, reports that lathes, planers, drill presses and small tools are in demand. Milling machines are not so commonly used. The British manufacturers are mainly supplying the trade, but there are no reasons why American manufacturers should not here have an important opportunity, because American machine tools, whenever imported to the country, have given the best satisfaction. Of lathes, the gap lathe style is most highly in favor.

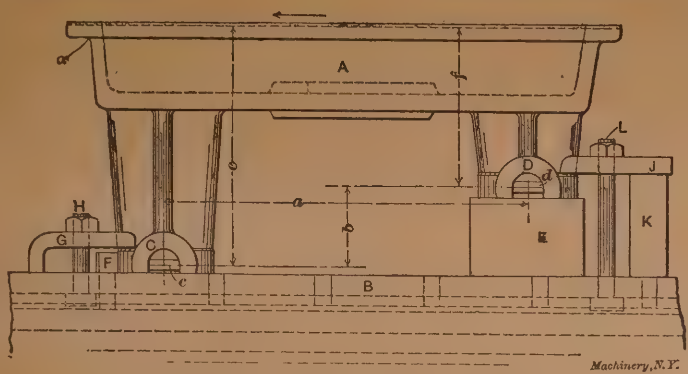
THE ITALIAN TARIFF.—Italy probably has the distinction of being, next to the United States, the most highly tariff-protected country in the world. At the present time there is,

PUNCH PUNCH PUNCH PUNCH PUNCH PUNCH.

These operation sheets, covering every class of shop work, are a feature of all Editions of MACHINERY, and appear every month. They may be cut along the top and margin lines for filing and binding. Suitable binders of sufficient capacity to hold four years' issues will be supplied by THE INDUSTRIAL PRESS, 49-55 Lafayette Street, New York, for 25 cents each, including postage.

SHOP OPERATION SHEET NO. 7.

Oscar E. Perrigo. MACHINERY, July, 1907.



To Plane the Bottom of a Machine Bed Casting.

1. Measure the casting carefully to see if it will finish to drawing. Insert brass pieces c and d in the shaft spaces; lay off the shaft centers on them with dimensions a, b, e and f to drawing, leaving equal finish at all points. If the casting will not finish, reject it and use another.

2. Set casting A bottom upwards, resting pedestal C on planer table B, and pedestal D on parallel blocks E, which should be high enough to bring the surface to be planed parallel to the planer table. Prove this by measuring with a scale from the planer table to the upper surface at each corner; or with a surface gage, its base resting on the table and its pointer on the upper surface of the work. Use thin sheet metal or steel wedges where necessary, to insure a solid bearing on the table and the parallel blocks.

3. Place pedestal C against stop plugs F in a direction to take the thrust of the cut. Clamp the work firmly to the table by two clamps G, secured by bolts H, whose heads enter T-slots in the table. Clamp pedestals D on blocks E by two clamps J, whose rear ends rest on blocks K and are secured by bolts L. If the work stands up so high as to chatter under the cut, provide stiff bracing from the table to the front end of work at x.

4. Test the work again, to see if the upper surface is parallel to the table. If not, slack the bolt at the low point and wedge the work up. Tighten the bolt again and test until found correct, taking care that the casting is not sprung in the process.

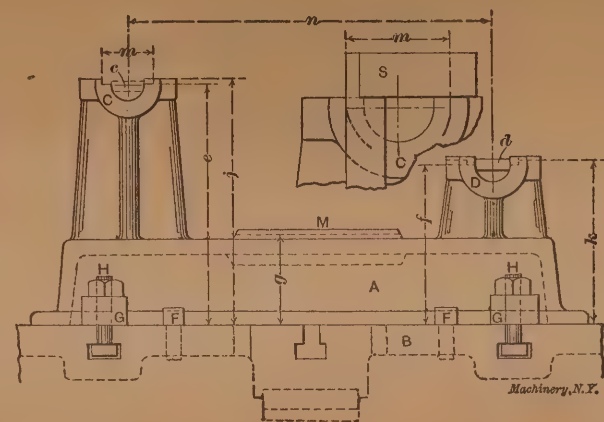
5. With a roughing tool take a roughing cut, leaving about 1-32 inch for a finishing cut; feed from 1-12 to ¼ inch, depending on the size of the casting; the larger the casting the coarser the feed.

6. Replace the roughing tool with a finishing tool, and take a cut down to dimension e; feed from ⅛ to ½ inch, according to the size of the casting.

7. Unclamp the casting, and test it with a surface gage. If it is sprung, wedge up, clamp down, and true up planed surface with a finishing tool, taking off as little as possible.

SHOP OPERATION SHEET NO. 8.

Oscar E. Perrigo. MACHINERY, July, 1907.



To Plane the Top Surface and Pedestal Boxes of a Machine Bed Casting.

1. The base of casting A is supposed to have been finished, and the centers of the holes have been laid out and prick-punched on brass pieces c and d, inserted in the shaft spaces. Place the work on planer table B as shown, the flange resting against two stop plugs F, in a direction to take the thrust of the cut. Fasten the work at the front with clamps G and bolts H, and likewise at the back side.

2. Chalk the front ends of the bearings in pedestals C and D. Set a pair of dividers to one-half of dimension m. With the prick-punch marks in c and d as centers, scribe arcs on each side of the center on the chalked faces of pedestals C and D. Remove the brass pieces c and d.

3. With a stiff roughing tool in the tool-post, take a roughing cut over the tops of the pedestals and the surface M, to within 1-32 inch of the dimensions g, j and k.

4. With a stiff finishing tool, cut down these surfaces to the exact dimensions g, j and k, using a light feed.

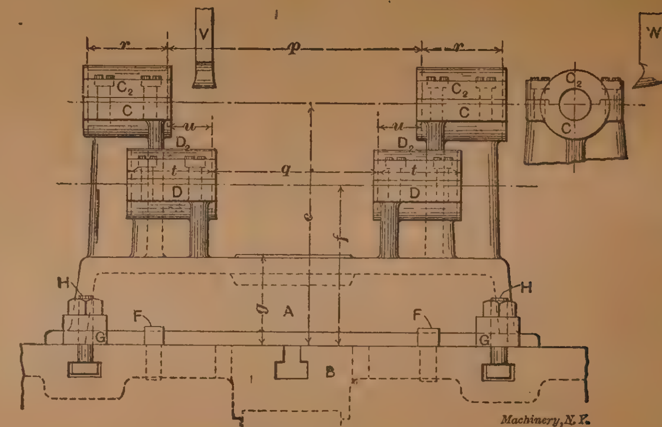
5. With a square S, placed as shown in the enlarged partial view, scribe on the chalked faces of the pedestals vertical lines tangent to (touching) the arcs scribed in Step 2. These lines locate dimension m for pedestal D and the corresponding dimension for pedestal C.

6. With a square end tool, cut down the cap seating in pedestals C to dimension e, determining the width of the cut by the lines scribed in Step 5. Repeat this cut on pedestals D, cutting down to dimensions f.

NOTE.—Vertical measurements may be made from the planer table with a scale, to a straight-edge laid across the surface being planed; or by the use of a surface gage whose pointer has been set to a scale. Where there is too much stock to be cut away at one roughing cut without undue chattering, two roughing cuts should be taken.

SHOP OPERATION SHEET NO. 9.

Oscar E. Perrigo. MACHINERY, July, 1907.



To Plane the End Surfaces of the Journal Boxes of a Machine Bed Casting.

NOTE.—The journal caps C_2 and D_2 are supposed to have been planed and fitted, drilled in place, the holes counterbored and tapped, and the screws put in place, as shown in the front view and the partial elevation at the right.

1. Place the casting A on the planer table, the flange resting against the plugs F F, in a direction to take the thrust of the cut. Secure the work at the front with clamps G and bolts H as shown, and likewise at the back side.

2. Chalk the casting at the necessary points, and lay off the dimensions r, p, r, u, and t, q, t, marking them with a scriber.

3. Select a stiff cutting-down tool as shown at V and W, and set it vertically in the planer head.

4. Beginning at the right, cut down outside of box C in two cuts, the second a very light one, and both with rather a fine feed to prevent chattering and springing of the casting.

5. In the same manner cut the inside of the same box, finishing to dimension r.

6. Repeat the operation on the inside of opposite box C, finishing to dimension p.

7. Repeat the operation on the outside of this box, finishing to dimension r.

8. Repeat these operations on the boxes in pedestals C, observing dimensions t, q, t, except that the first cuts are made on the inside of one of the boxes to the dimension u.

NOTE.—The lateral dimensions of a piece of work like this may be laid off by using the cross-rail and heads of the planer as a beam caliper. Use both heads, one clamped in place as the fixed jaw, and the other (carrying a sharp pointed tool or scriber) as the movable jaw. Measurements are laid off by using a scale or inside micrometer caliper between any convenient finished surfaces on the slides. The measurements thus found are transferred step by step to the casting, using the scriber mounted in the tool-post.

DIMENSIONS FOR HUNG BOILERS.—I.

			15	20	25	30	35	40	45	50	55	60	70	75
	Horse-Power of Boiler		15	20	25	30	35	40	45	50	55	60	70	75
BOILER	Diameter of Boiler (inches)		36	36	36	40	42	46	48	48	52	54	54	60
	Length of Tubes (feet)		8	10	12	12	12	12	12	14	14	14	16	14
	Total length of Shell (feet)		$9\frac{1}{2}$	$11\frac{1}{2}$	$13\frac{1}{2}$	$13\frac{1}{2}$	$13\frac{1}{2}$	$13\frac{1}{2}$	$13\frac{1}{2}$	$15\frac{1}{2}$	$15\frac{1}{2}$	$15\frac{1}{2}$	$17\frac{1}{2}$	$15\frac{1}{2}$
	Total weight in pounds (approx)	of Boiler and Fixtures	4250	4640	5300	6400	7300	8250	8840	9650	11800	12900	15500	17100
		of Water	2800	3500	4200	5100	5800	6900	7700	9000	10200	11300	12900	13500
		of Boiler, Fixtures and Water	7050	8140	9500	11500	13100	15150	16540	18650	22000	24200	28400	30600
HANGER BOLTS	Front Head to center of Hanger (inches)		5	9	12	12	12	12	12	17	17	17	25	17
	Rear Head to center of Hanger (inches)		$15\frac{1}{2}$	$18\frac{1}{2}$	$23\frac{1}{2}$	$23\frac{1}{2}$	$23\frac{1}{2}$	$23\frac{1}{2}$	$23\frac{1}{2}$	$31\frac{1}{2}$	$31\frac{1}{2}$	$31\frac{1}{2}$	$31\frac{1}{2}$	$31\frac{1}{2}$
	Center to center of Hangers (inches)		$75\frac{1}{2}$	$92\frac{1}{2}$	$108\frac{1}{2}$	$108\frac{1}{2}$	$108\frac{1}{2}$	$108\frac{1}{2}$	$108\frac{1}{2}$	$119\frac{1}{2}$	$119\frac{1}{2}$	$119\frac{1}{2}$	$135\frac{1}{2}$	$119\frac{1}{2}$
	Diameter of Hanger Bolts (inches)		1	1	1	1	1	1	1	1	$1\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{1}{4}$
	Length of Hanger Bolts (inches) using I-Beams	one Boiler	19	19	20	19	18	28	27	27	32	30	32	44
		two Boilers	23	23	23	22	21	31	30	30	35	34	35	47
		three Boilers	25	25	25	24	23	34	33	33	38	39	40	52
	Length of Hanger Bolts (inches) using Channel Beams	one Boiler	20	21	22	21	20	30	29	29	35	33	34	46
		two Boilers	25	25	25	24	23	34	33	33	38	36	37	49
		three Boilers	27	27	27	26	25	37	36	36	41	39	40	52
COLUMNS	Center to center of Columns (inches)	one Boiler	69	69	69	73	75	78	87	87	92	94	94	110
		two Boilers	124	124	124	136	140	150	161	161	170	173	173	195
		three Boilers	180	180	180	200	206	222	234	234	247	253	253	281
	Length of Columns (feet)		8	8	8	$8\frac{1}{2}$	$8\frac{1}{2}$	$9\frac{1}{2}$	$9\frac{1}{2}$	$9\frac{1}{2}$	10	10	10	$11\frac{1}{2}$
	Diameter of C.I. Columns (inches)	one Boiler	4	4	4	4	4	5	5	5	5	5	5	5
		two Boilers	5	5	5	5	5	5	5	5	5	6	6	6
		three Boilers	5	5	5	5	5	5	6	6	6	6	6	6
	Thickness of Metal of C.I. Columns (inches)	one Boiler	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
		two Boilers	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{5}{8}$	$\frac{5}{8}$	$\frac{5}{8}$	$\frac{5}{8}$	$\frac{5}{8}$	$\frac{5}{8}$
		three Boilers	$\frac{5}{8}$	$\frac{5}{8}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{5}{8}$	$\frac{5}{8}$	$\frac{5}{8}$	$\frac{5}{8}$	$\frac{5}{8}$	$\frac{3}{4}$
	Size of Cap and Base of C.I. Columns (inches)	one Boiler	8x8	8x8	8x8	8x8	8x8	9x9	9x9	9x9	9x9	9x9	10x10	10x10
		two Boilers	10x10	10x10	10x10	10x10	10x10	10x10	10x10	10x10	10x10	12x12	12x12	12x12
		three Boilers	12x12	12x12	12x12	12x12	12x12	12x12	12x12	12x12	12x12	13x13	13x13	13x13

Contributed by G. L. Preacher.

No. 45, Data Sheet, RAILWAY MACHINERY, July, 1907.

DIMENSIONS FOR HUNG BOILERS.—II.

			15	20	25	30	35	40	45	50	55	60	70	75
	Horse-Power of Boiler		15	20	25	30	35	40	45	50	55	60	70	75
I-BEAMS AND CHANNELS	Center to center of Boilers (inches)		56	56	56	64	66	72	74	74	78	80	80	86
	Length of I-Beams or Channel Beams required for (inches)	one Boiler	77	77	77	81	83	88	98	98	102	104	104	120
		two Boilers	134	134	134	146	150	160	171	171	180	185	185	207
		three Boilers	192	192	192	210	218	234	246	246	259	266	266	294
	Size of I Beams required for (inches)	one Boiler	4	4	5	5	5	6	6	6	6	6	7	7
		two Boilers	8	8	8	8	8	9	9	9	9	10	10	10
		three Boilers	10	10	10	10	10	12	12	12	12	15	15	15
	Size of Channel Beams required for (inches)	one Boiler	5	6	7	7	7	8	8	8	9	9	9	9
		two Boilers	10	10	10	10	10	12	12	12	12	12	12	12
		three Boilers	12	12	12	12	12	15	15	15	15	15	15	15
	Weight per foot of I-Beams required for (pounds)	one Boiler	$7\frac{1}{2}$	$8\frac{1}{2}$	$9\frac{3}{4}$	$9\frac{3}{4}$	$12\frac{1}{4}$	$12\frac{1}{4}$	$12\frac{1}{4}$	$12\frac{1}{4}$	$14\frac{3}{4}$	$14\frac{3}{4}$	15	15
		two Boilers	$17\frac{3}{4}$	$17\frac{3}{4}$	$17\frac{3}{4}$	$20\frac{1}{4}$	$20\frac{1}{4}$	21	21	21	21	25	25	25
		three Boilers	25	25	25	30	30	$31\frac{1}{2}$	$31\frac{1}{2}$	35	35	42	42	42
	Weight per foot of Channel Beams required for (pounds)	one Boiler	$6\frac{1}{2}$	8	$9\frac{3}{4}$	$9\frac{3}{4}$	$9\frac{3}{4}$	$11\frac{1}{4}$	$11\frac{1}{4}$	$11\frac{1}{4}$	$13\frac{1}{4}$	$13\frac{1}{4}$	$13\frac{1}{4}$	$13\frac{1}{4}$
		two Boilers	15	15	15	20	20	$20\frac{1}{2}$	$20\frac{1}{2}$	$20\frac{1}{2}$	$20\frac{1}{2}$	25	25	25
		three Boilers	25	25	25	25	25	33	33	33	33	55	55	55
BRICK	Number of Fire Bricks required to set	one Boiler	600	700	800	850	875	900	950	1050	1300	1350	1400	1450
		two Boilers	1200	1400	1600	1700	1750	1800	1900	2100	2600	2700	2800	2900
		three Boilers	1800	2100	2400	2550	2625	2700	2850	3150	3900	4050	4200	4350
	Number of Common Bricks required to set	one Boiler	4100	4200	4800	6800	7200	9300	10300	11400	13600	14000	14500	15800
		two Boilers	7150	7300	8400	11900	12400	15100	16700	18525	22100	22750	23600	25700
		three Boilers	10200	10500	12000	17000	17600	20900	23100	25650	30600	31500	32700	35550

Contributed by G. L. Preacher

No. 45, Data Sheet, RAILWAY MACHINERY, July, 1907.

Contributions and data suitable for publication in these Data Sheets are

d for if accepted. Only data not available in handbooks are desired.

This data sheet may be cut into four sections, 6x9 inches in size and bound into note-book form for convenient reference, by means of staples inserted into holes punched at the points indicated.

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DIMENSIONS FOR HUNG BOILERS.—III.

	Horse-Power of Boiler		85	90	100	115	125	150	175	175	200	200	225	225	250
BOILER	Diameter of Boiler (inches)		60	66	66	66	72	72	72	78	78	84	84	90	90
	Length of Tubes (feet)		16	15	16	18	16	18	20	18	20	18	20	18	20
	Total length of Shell (feet)		17½	16½	17½	19½	17½	19½	21½	19½	21½	19½	21½	19½	21½
	Total weight in pounds (approx)	of Boiler and Fixtures.	19400	21000	23700	25100	28000	29500	30800	32000	34100	34500	36200	37000	39000
		of Water.	15400	15500	16500	18550	20800	23400	26000	28400	31600	33000	36800	37500	40000
		of Boiler, Fixtures and Water.	34800	36500	40200	43650	48800	52900	56800	60400	65700	67500	73000	74500	79000
HANGER BOLTS	Front Head to center of Hanger (inches)		25	21	25	25	25	25	25	25	25	25	25	25	25
	Rear Head to center of Hanger (inches)		31½	31½	31½	31½	31½	31½	31½	31½	31½	31½	31½	31½	31½
	Center to center of Hangers (inches)		135½	127½	135½	159½	135½	159½	183½	159½	183½	159½	183½	159½	183½
	Diameter of Hanger Bolts (inches)		1¼	1¼	1¼	1¼	1¼	1¼	1½	1½	1½	1½	1½	1½	1½
	Length of Hanger Bolts (inches) using I-Beams	one Boiler	44	41	41	41	39	39	39	49	50	53	53	56	56
		two Boilers	49	46	46	46	46	46	45	58	58	61	61	64	66
		three Boilers	52	49	52	52	49	51	50	64	64	67	67	70	70
	Length of Hanger Bolts (inches) using Channel Beams	one Boiler	46	43	43	43	41	41	42	52	52	55	55	58	58
		two Boilers	52	49	49	49	46	46							
		three Boilers													
COLUMNS	Center to center of Columns (inches)	one Boiler	110	115	115	115	121	121	121	126	126	132	132	138	138
		two Boilers	195	207	207	207	219	219	219	230	230	242	242	254	254
		three Boilers	281	299	299	299	316	316	316	333	333	351	351	369	369
	Length of Columns (feet)		11½	11½	11½	11½	11½	11½	11½	12½	12½	13	13	13½	13½
	Diameter of C.I. Columns (inches)	one Boiler	5	6	6	6	6	6	6	7	7	7	7	7	7
		two Boilers	6	6	6	6	6	6	6	7	7	7	7	7	7
		three Boilers	6	6	6	6	7	7	7	8	8	8	8	8	8
	Thickness of Metal of C.I. Columns (inches)	one Boiler	½	⅝	⅝	⅝	⅝	⅝	⅝	⅝	⅝	¾	¾	¾	¾
		two Boilers	⅝	¾	¾	¾	¾	¾	¾	¾	¾	¾	¾	1	1
		three Boilers	¾	⅞	⅞	⅞	¾	¾	¾	¾	¾	1	1	1	1
	Size of Cap and Base of C.I. Columns (inches)	one Boiler	10x10	10x10	10x10	10x10	10x10	10x10	12x12	12x12	12x12	12x12	12x12	12x12	12x12
		two Boilers	12x12	12x12	12x12	12x12	13x13	13x13	13x13	14x14	14x14	14x14	14x14	14x14	15x15
		three Boilers	13x13	13x13	14x14	14x14	14x14	15x15	15x15	16x16	16x16	16x16	16x16	16x16	16x16

Contributed by G. L. Preacher.

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DIMENSIONS FOR HUNG BOILERS.—IV.

	Horse-Power of Boiler		85	90	100	115	125	150	175	175	200	200	225	225	250
I-BEAMS AND CHANNELS	Center to center of Boilers (inches)		86	92	92	92	98	98	98	104	104	110	110	116	116
	Length of I-Beams or Channel Beams required for (inches)	one Boiler	120	127	127	127	133	133	133	140	140	146	146	152	152
		two Boilers	207	219	219	219	232	232	232	244	244	256	256	268	268
		three Boilers	294	312	313	313	330	331	331	349	349	367	367	385	385
	Size of I-Beams required for (inches)	one Boiler	7	7	7	7	8	8	9	9	10	10	10	10	10
		two Boilers	12	12	12	12	15	15	15	18	18	18	18	18	20
		three Boilers	15	15	18	18	18	20	20	24	24	24	24	24	24
	Size of Channel Beams required for (inches)	one Boiler	9	9	9	9	10	10	12	12	12	12	12	12	12
		two Boilers	15	15	15	15	15	15							
		three Boilers													
	Weight per foot of I-Beams required for (pounds)	one Boiler	15	17½	17½	17½	17¾	20¼	21	25	25	25	30	30	30
		two Boilers	31½	31½	35	40	42	42	45	55	55	55	60	60	65
		three Boilers	45	45	55	55	60	65	65	80	80	80	85	85	90
	Weight per foot of Channel Beams required for (pounds)	one Boiler	13¼	15	15	15	15	20	20½	20½	25	25	30	30	30
		two Boilers	33	33	33	40	55	55							
		three Boilers													
BRICK	Number of Fire Bricks required to set	one Boiler	1550	1650	1700	1800	1850	1900	1950	2000	2050	2100	2100	2150	2200
		two Boilers	3100	3300	3400	3600	3700	3800	3900	4000	4100	4200	4200	4300	4400
		three Boilers	4650	4950	5100	5400	5550	5700	5850	6000	6150	6300	6300	6450	6600
	Number of Common Bricks required to set	one Boiler	17500	18000	18300	18500	19000	20800	22000	22800	23900	24100	26000	27000	29000
		two Boilers	28500	29250	29800	30100	30800	33800	35750	37050	38900	39150	42250	43900	47100
		three Boilers	39500	40500	41300	41700	42600	46800	49500	51300	53900	54200	58500	60800	65250

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RAILWAY MACHINERY.

A special edition of MACHINERY devoted to Locomotive and Car Equipment and Mechanics.

August, 1907.

THE BRENNAN MONO-RAIL CAR.

THE accompanying illustration shows one of the cars of the English mono-railway designed by Louis Brennan, the well-known inventor of the Brennan torpedo, which was purchased two decades ago by the British government for over half a million dollars. The car shown in the illustration was constructed for demonstration purposes in order to prove the practicability of the use of a single rail line on which vehicles might travel at velocities several times those attained under present conditions.

It is maintained that there will be a great increase in the smoothness of operation of the cars on the mono-railway, with an entire absence of lateral oscillation and with greater comfort to the passenger, while for freight traffic many commodities may be carried in bulk instead of in small parcels, now necessary on account of the limited size of railway cars. A very wide type of car is now being constructed for practical demonstration, using the Brennan principle of gyrostatic action of rotating bodies as applied to the mono-railway.

The car of the Brennan mono-railway is capable of maintaining its balance upon an ordinary single rail whether it is moving in either direction at any rate of speed or whether it is standing still. This is true notwithstanding the fact that the center of gravity is several feet above the rail, and regardless of the fact that any combination of the forces of centrifugal action, wind pressure, or shifting of load may tend to upset it, for the car is endowed with the power of maintaining itself upright by means of electric motors driving at high speed two fly-wheels which are rotated in opposite directions in a vacuum. The bearings used for mounting these fly-wheels are of the "anti-friction" type, and as the cases in which they run have the air exhausted, the resistance is reduced to a minimum.

It is a remarkable fact that even with the current cut off from the electric motors these fly-wheels will operate for several days before they will come to rest on account of the small friction due to the vacuum and the high class bearings provided, and they will impart stability to the car for several hours after the current has been shut off, while the mechanism is of comparatively light weight and located in the cab at one end of the car.

The driving wheels are in a single row under the center of the car, and these vehicles can, therefore, run on curves of very small radius, and over uneven ground, without danger of the cars being derailed.

The Brennan mono-rail car may be operated by electric motors, or steam, or internal combustion engines. The first practical test will include a gasoline electric generating outfit carried on the car itself, the current being used for operating the driving wheel as well as the stability mechanism by means of electric motors, while a storage battery will be provided for running the gyrowheel-motors when the engine is at rest. This experimental car to be used for practical demonstrations will be nearly double the width of the ordinary car, or twelve feet in width, while it is maintained that in the British colonies the cars will be even wider, and pneumatic brakes will be provided. It is stated that for military service lines of railway can be laid with great rapidity over uneven ground, and it will be possible to keep up with an army on the march and supply the same with ammunition and provision without difficulty; special building cars are contemplated for this purpose, equipped with electric power for hauling and laying the rails with great speed. The cars having their own motive power can go wherever a single rail is laid.

It is maintained that these cars will travel with greater safety and even higher speeds than present railway cars, without the danger of derailment, while the cost of maintenance as well as the first cost of construction will be smaller.

F. C. P.

Brennan Mono-rail Car Model Heavily Loaded on one Side.

[The principle of the Brennan mono-rail car is interesting, and a description of the balancing mechanism is given on page 684 of this issue. Notwithstanding its novelty and apparent wide applicability, however, it offers very little for the practical improvement of the commercial railway. The fact that only one rail is required, for example, does not necessarily mean economy, for with the same loads a much heavier rail must be used. In fact, it is quite probable that the existing wheel loads could not be carried by a mono-rail car or locomotive for the reason that the unit pressures on tire and track are already dangerously near the limit of the crushing strength of track steel.—EDITOR.]

ELECTRIC RAILWAY MACHINERY AND APPARATUS.—6.

WM. BAXTER, JR.

Multipolar Armature Winding.

If Figs. 34, 35, 36 (July issue) are examined it will be noticed that in each one the coils of wire are wound so that the two sides rest on points of the armature that are diametrically opposite, or nearly so. In actual machines the two sides are exactly opposite in one style of winding, which is not often used as it requires unnecessary crossing of the wires; but in the winding generally used, the coils reach around just one coil less than half the circumference, or as shown in Fig. 36. The number of coils on an armature is generally between fifty and one hundred, so that the sides are practically opposite. This position of the coil sides is necessary so that while one side is passing in front of one pole of the field, the other side may be passing in front of the other pole. Now in the two-pole, or bipolar, machines for which armatures wound as in Figs. 34, 35 and 36 are required, the opposite poles are positive and negative, while in a four-pole motor or generator, they are both either positive or negative, as can be seen from Fig. 43, hence, for the latter, this type of winding would not be proper. If a diagram of a six-pole machine is made, it will be found that by marking the poles *P* and *N* consecutively around the circle, the opposite poles will be marked *P* and *N*, and similarly if an eight-pole diagram is drawn and marked, the opposite poles will be marked *P* and *P* or *N* and *N*, while in a ten-pole diagram they will be as in the six-pole, that is, *P* and *N*. Thus we will find that if the field has an even number of pairs of poles, the opposite poles will be alike, while if the number of pairs of poles is odd, the opposite poles will be unlike. This being the case, it is evident that an armature wound in the way shown in Figs. 34, 35 and 36, can be used in any multipolar machine having an odd number of pairs of poles, if we provide brushes at suitable points to take off the current. It is also evident that in machines having an even number of pairs of poles, this winding cannot be used.

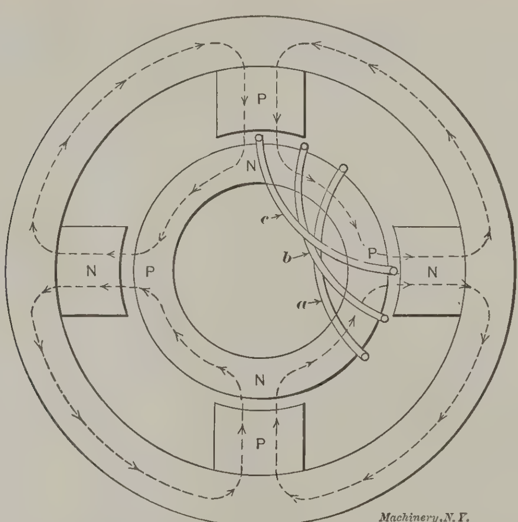


Fig. 43. Diagram of Multipolar Armature.

Although this winding can be used in machines having an odd number of pairs of poles, it can be seen at once from Fig. 43 that it is not desirable even in these cases, because a considerable amount of wire can be saved by using a winding that is designed for the number of poles with which it is to be used. In any armature the length of the arc covered by the coils must be such that while one side is opposite the center of a positive pole, the other side is opposite the center of a negative pole, hence, in a four-pole armature the arc covered is only one-quarter of the circle, in a six-pole armature it is one-sixth of the circle, and in a ten-pole armature, one-tenth of the circle; so that the greater the number of poles the greater the saving in wire by using the proper winding.

Form of Coils for Multipolar Armature Winding.

The coils placed on multipolar armatures are in almost every case wound upon a form, and then placed upon the armature core. This style of winding, which is commonly called formed coil winding, can also be used with two-pole armatures, but is more difficult, owing to the greater arc covered by the coils, and is not generally used. In order that formed coils may be used, they must be so formed that they will fit into each other, otherwise they cannot be placed upon the core. This can be readily understood from looking at Fig. 43. Suppose we were to wind a coil in place, as shown at *a*, and then another coil adjoining it at *b*, and a third coil at *c*. It is evident that coil *a* can be placed close to the end of the armature core, but *b* cannot be so placed, as it will have to ride over *a*, and for the same reason *c* cannot be placed as close as either *b* or *a*, as it will have to ride over these two. Thus it will be seen that the three coils will have different shapes at the ends. Now to be able to use coils wound on a form they must all have ends of the same shape, and this shape will depend on the position in which the coil ends are to rest. In Fig. 43 the ends run down at right angles to the shaft, and coils so formed are said to have radial ends. In other armatures the ends run out parallel with the shaft, and these are called barrel-shaped coils. Other armatures have coil ends that run at an angle that may be anywhere between zero and 90 degrees. The form of coils of the latter type can be clearly seen in Fig. 44, which shows a General Electric railway motor armature with a portion of the coils in place. An armature wound with coils having radial ends is shown in Fig. 45, and the form of the coils is shown in Fig. 46. Fig. 47 shows an armature with barrel-shaped coils, these being made of copper strips, as the coils have but one turn each.

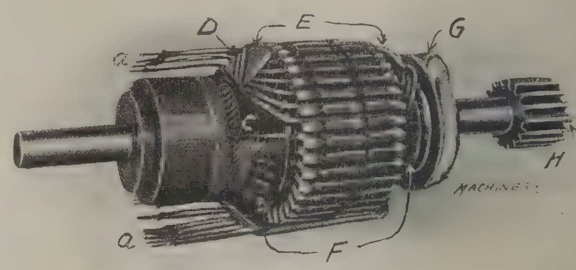


Fig. 44. General Electric Co.'s Railway Motor Armature.

Method of Connecting Coils of Multipolar Armatures.

The coils of multipolar armatures are connected in two ways, one of which is known as the parallel, or lap winding, and the other as the series or wave winding. Each type is used extensively, and one is as good as the other, but each possesses features that make it more desirable for certain cases. The way in which the ends of the coils are connected with one another, and with the commutator segments, can be made clear by means of a few simple diagrams. In Fig. 48 a parallel or lap winding is illustrated with radial coils. Here the coils are supposed to have one turn each, so as to simplify the diagram. The end *a* of the wire is secured to a commutator segment, and then the wire follows the path indicated by the line to *b*, *c* being the return side of the first coil. The ends of the first and second coils are connected

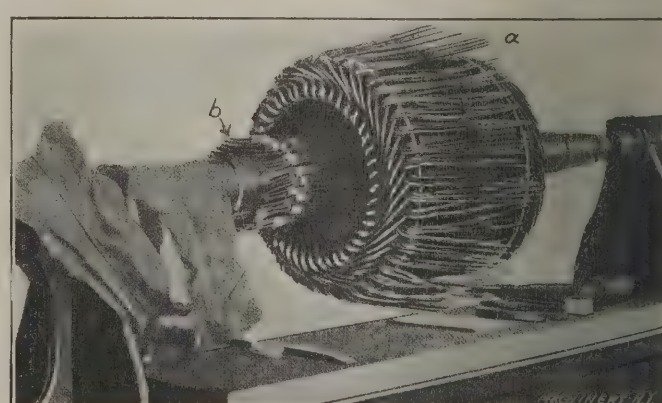


Fig. 45. Armature with Coils having Radial Ends.

with the commutator segment adjoining the one with which a is connected. The return side of the second coil is at d, and the end of this is connected with b, and with the commutator segment two ahead of the one with which a is connected. The connection of the coil ends continues in this way until all the coils are connected with all the commutator segments. In cases where the coils are placed upon an armature core that has a smooth surface, the coils are placed so that there is a space between them as wide as the coil side, so that when a sufficient number of coils have been put in place to cover the space between the sides of the first coil, the remaining coils may have their entering side placed in the spaces between the first coils. Smooth core armatures for multipolar machines are never made at the present time, and in the grooved armature cores, one side of the coils occupies the lower half, while the other side fills the upper half, as is very clearly shown in Figs. 44 and 47. The way of connecting the coils illustrated in Fig. 48 is called a lap winding, because the connection of the coil ends causes the

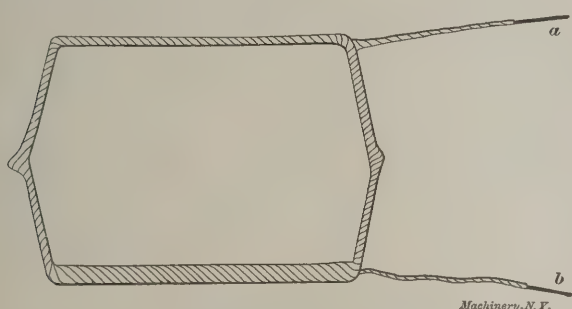


Fig. 46. Armature Coil.

currents to lap over each other, as will be clearly seen by following the line from a to b. It is also called a parallel winding because in multipolar machines in which it is used, it is necessary to have as many commutator brushes as there are poles, these being equally spaced around the commutator, and the currents flow from one brush to the adjoining one on either side, so that if there are six brushes, the current will pass out of the armature coils through three of them, the odd-numbered ones, and will enter the armature through the three even-numbered ones. From this it will be seen that the total number of coils on the armature is divided into six sections, in each one of which there is a current flowing from one brush to the next one, and these six currents are in parallel with each other, because the three odd number brushes are connected with one side of the circuit, and the even number brushes with the other side, and the currents flow away from the three brushes of one set and toward the

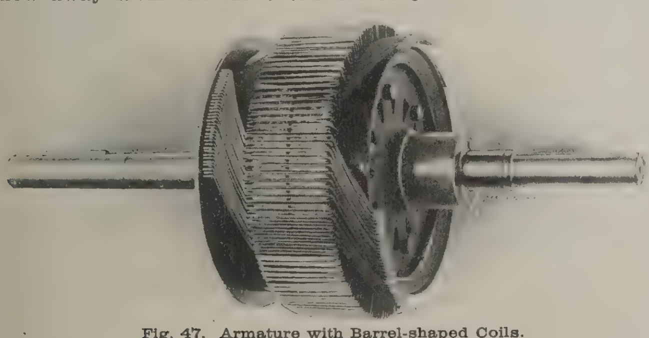


Fig. 47. Armature with Barrel-shaped Coils.

other three. In a four-pole machine there are four brushes, and the currents flow from the two diametrically opposite toward the other two.

Wave or Series Winding of Multipolar Armature.

The wave, or series winding, is illustrated in the diagram, Fig. 49, which is so simple as to require very little explanation. The connection of the coil ends in this case is not with the adjoining coil, but with one that is located two-pole spaces in advance; thus starting from a the path is through side b of the first coil, to side c, and thence to i, where a connection is made with side d of a coil on the opposite side of the armature core, the other side of this coil being at e. At h the end of side e is connected with the beginning f of the third coil to be connected, and thus the connecting goes on around the armature turn after turn until all the coils are connected. This style of connection is called wave winding, because the path of the current through the coils forms a wave line, as is shown in the diagram. It is also called a series winding because the current has to pass through all the coils placed upon the armature before it can reach the opposite brush. With a parallel winding it is necessary to have as many commutator brushes as there are poles, but with a series winding, two brushes are sufficient, and these

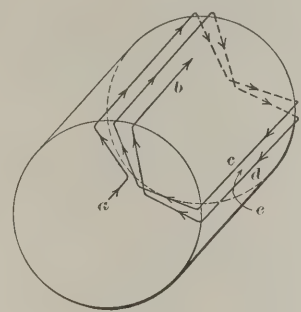


Fig. 48.

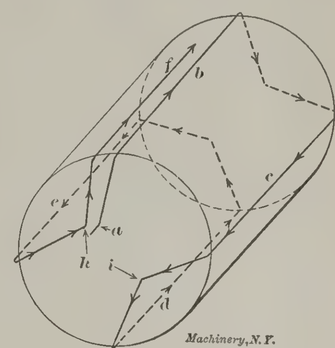


Fig. 49.

can be placed one pole space apart, or any odd number of spaces apart. The number of brushes can also be made equal to the number of poles, or any even number less than this can be used. Thus in a ten-pole generator, with series winding, the number of brushes can be ten, equally spaced, or it can be two, four, six or eight. As a rule the full number of brushes is used on generators, that is as many as the number of poles, this being done so as to obtain a sufficient brush contact surface, without making the commutator with a very wide face. Railway motors are made with a series-wound armature, and only two brushes are used, because these can be placed on the upper side of the commutator where they can be easily reached whenever desired, and also where they can be fully seen so as to ascertain whether they are running with as little sparking as they should.

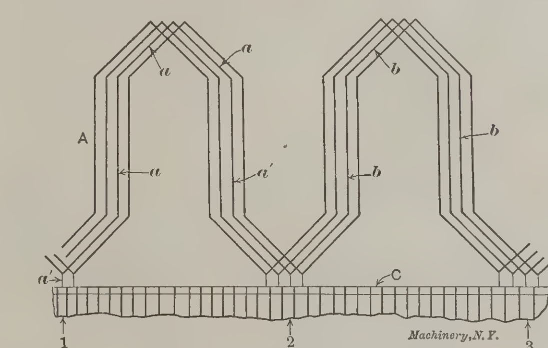


Fig. 50. Diagram of Series Winding.

The difference between series and parallel windings, or wave and lap, as they are commonly called, can be made still clearer by means of diagrams, such as are shown in Figs. 50 and 51, the first showing the series, and the second the parallel connection. These diagrams show the coils of a barrel wound armature rolled out upon a flat surface, and thus bring out clearly the difference in the connection. In Fig. 50 it will be seen that the two ends of the coils are turned away from each other, so that the commutator segments with which they are connected are a distance apart that is about twice as great as the distance between the sides of the coil, that is, the distance between commutator segments 1 and 2 is about twice as great as the distance between the coil sides a a'. In Fig. 51 the commutator segments 1 and 2 are side by side, and the ends of the coils instead of being bent outward are bent inward. In Figs. 50 and 51 only a portion of the armature surface is shown, but if the whole surface were presented, by cutting the piece out and bending it around in the form of a cylinder, the two edges of the diagram would match each other and show accurately the position of the coils and the connection of their ends with one another and with the commutator segments, for a barrel-shaped armature.

Object of Series and Parallel Connections of Armature Coil.

When it is desired to obtain as high a voltage as possible from a generator armature, without using very small wire, the coils are connected in series so as to add the electromotive forces of all the coils. In a motor the series connection is used for the purpose of reducing the speed to the lowest point without using very fine wire. With the parallel winding the voltage of the generator can be made just as high, and the speed of the motor just as low, if the number of turns in the coils corresponding to one pair of poles is made equal to the total number of turns in all the coils for a series winding. Thus, if we have a six-pole armature and there are 120 coils, with five turns of wire in each coil, the total number of turns on the armature will be 600, and if we use the

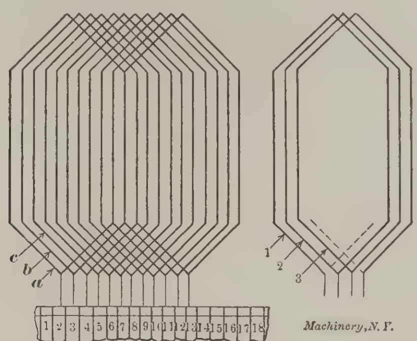


Fig. 51. Diagram of Parallel Winding.

series connection we will obtain a voltage in the generator, or a speed in the motor, corresponding to 600 turns of wire. If we wish to substitute the parallel for the series winding, we must place fifteen turns of wire in each coil, so that the coils corresponding to one pair of poles, which is 40, may contain 600 turns. Now, if we wind fifteen turns of wire in the space of five, it is evident that they must be one-third the cross-section, and this may make the wire too small.

Advantages of Series Winding.

One advantage of the series winding is that the current flowing through all the coils is of the same strength, while in the parallel winding it may not be, for the reason that in the coils that are passing in front of poles that are nearer to the armature the E. M. F. developed will be higher. As the bearings wear away gradually, the distance between the

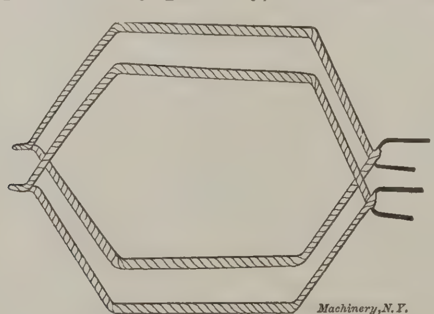


Fig. 52. Completed Armature Coils.

pole faces and the armature cannot be kept alike at all the poles, hence, in parallel-wound armatures the currents flowing in different parts of the coils are not of the same strength.

Advantages of Parallel Winding.

To offset this objection we have the fact that in the series winding the total number of wires on the armature cannot be varied by such a small amount, therefore the generator voltage, or motor speed cannot be changed so small an amount by simply changing the number of turns of wire in the coil. To make this point clear, let us take the above examples in which the series wound armature with 120 coils of five turns each will give the same voltage as the parallel-wound armature having the same number of coils, which equals 40 coils per section, each one having fifteen turns of wire instead of five. Now, in the series armature, if we add one turn to each coil we will increase the voltage in the ratio of 6 to 5, and if we take out one turn we will reduce the voltage in the ratio of 4 to 5. Now, in the case of the parallel winding, if we add one turn the number of turns per coil will be increased from 15 to 16 with a like increase in the voltage, and if we reduce the number of turns to 14, the voltage will be reduced in the same proportion. Thus it will be seen that if we desire to increase the voltage about six or seven per cent, we can do it in the parallel connected armature by simply increasing the number of turns of wire in each coil from 15 to 16, but to make this change in the voltage of the series connected armature we would have to change the proportions of the whole machine, because adding one turn of wire to each coil would give us an increase in voltage of 20 per cent and to reduce this to the amount desired we would have to reduce the strength of the field. In machines of large size, where the coils of a series connected armature would consist of a single turn, this point becomes more pronounced, because in such a machine the addition of one turn to the coil would double the voltage. From this it will be seen that in the design of a line of motors or generators of graduated sizes and uniform design, it is easier to preserve the regularity of proportions with parallel winding.

How to Distinguish Series from Parallel Connected Armature.

It is not difficult to determine whether an armature that is already wound is series or parallel connected; this is particularly true if it is so large as to have coils of a single turn of wire. Looking at Fig. 47, it will be seen that the ends of the coils on the right and left of the armature surface are bent in opposite directions. This is a series winding. If it were a parallel winding the ends of the coils on the right side of the armature would bend toward each

Fig. 53. Armature Core, showing Coils.

other, so that the lower ones would bend upward. Now the lower ones are on the surface, and are seen when the armature is finished, so that by looking at the ends of such an armature we can determine whether it is series or parallel connected by noting the direction in which the ends of the coils run. If they are as in Fig. 47 the connection is series, and if opposite to this it is parallel.

When the coils are made of several turns it is not so easy, but still possible. If the coils are to be connected in series the ends of the wire will be brought out at the corners, as is shown in Fig. 46, but if the parallel connection is to be used, the wire ends will come out at the center, as in Fig. 52. When the armature is completed and the wires are connected with the commutator, an examination of the ends will enable us to see whether they come from the center of the coil end or from the corners. Fig. 44 shows a series-wound armature partially wound, and it will be seen that the wires from the outer corners, marked *a a*, run above the surface of the coils, while the ends from the under corners, marked *c*, run under the coils, and are separated from them by an insulating covering *F*. *E* is an insulation between the two layers formed by the ends of the coils, and *G* is an insulation that is pulled over the back ends of the coils after they are all in place. From Fig. 44 it can be seen that if we can make sure that the coil ends *a a* run from the coil corners, and form a layer above the coil ends, the connection is series. This fact is made still clearer in Fig. 45, in which all the outer ends *a* of the coils are bent back, while all the inner ends *b* are bent together around the shaft. Fig. 53 shows an armature with a few coils upon it that are wound for parallel connection, that is, with the wire ends coming out at the center. When this armature is filled with coils and these are connected with the commutator segments, it will not be difficult to ascertain whether the wires connecting with the segments came from the ends of the coils, or from the corners.

NILES GANTRY CRANE.

A Niles gantry crane, lately installed at the South Chicago Works of the Illinois Steel Company, is of 15 tons capacity, and runs on a track 56 feet center to center of rails. The cantilever extends 12 feet 9 inches on one end, and 28 feet 3 inches on the opposite end, making the total length of girders 97 feet.

The main girders are built up of universal mill plates and angles fastened together by lattice angles. The auxiliary girders are of lattice construction so arranged as to secure great strength and rigidity and minimum wind surface. The girders are supported upon structural steel pillars or A-frames extending above the girders, where they are held together, allowing sufficient space beneath for the passage of the trolley, which is free to traverse the entire length of the crane.

The supporting columns are connected at the lower ends by substantial bridge trucks, each truck carrying four truck wheels, mounted in pairs with equalizing connections to the bridge trucks. Two of these equalizing truck wheels on each bridge end are connected by spur gears and pinions. The bridge drive shaft is connected to each pair of equalizing truck wheels by miter gears and vertical shafts, these shafts being supported by roller thrust bearings. The bridge trucks are equipped at each end with a pilot. The bridge drive motor is located on the girders near the center of the span, where it is connected by a spur gear and pinion to the steel bridge drive shaft, which is carried in cap bearings and uniformly supported the entire length. The motor is equipped with a powerful foot brake of the Post type, the brake shoes being withheld from contact with the brake drum except when applied by the operator. This brake is operated by a foot lever conveniently located in the cage. A foot-walk extends the entire length of the bridge drive shaft, allowing easy access to all gears and bearings.

Fig. 1. Niles Gantry Crane, End View.

Fig. 2. Niles Gantry Crane, Installed in the Illinois Steel Co.'s Works, South Chicago.

The trolley is of steel construction, the design being such as to eliminate all overhung gears. The truck axles revolve in bronze bearings with standard waste cellars beneath. The hoisting mechanism is equipped with both electric and mechanical load brakes, running in an oil bath. All gears throughout the crane are cut from solid steel castings, the pinions from open-hearth steel forgings.

The speed of the hoist is 30 feet per minute, when lifting a load of 15 tons. The trolley speed is 150 feet per minute, and bridge speed 250 feet per minute under same conditions. The entire trolley is fully enclosed in order to protect it from atmospheric conditions.

AMERICAN LOCOMOTIVE COMPANY'S JAMESTOWN EXHIBIT.

Two of the locomotives which form part of the American Locomotive Company's exhibit at the Jamestown Exposition are shown in the accompanying illustrations. Both are of the consolidation type, and while representing no unusual features of construction, are excellent examples of modern freight engines. The engine for the Southern Railway represents a class of which there are 86 built by the same company now in service on the road. The Chesapeake & Ohio engine is one of an order of two locomotives which are known on the road as class G-8. Both engines were built at the Richmond Works of the company, and in the size of cylinders and weight in working order the two designs are identical. Engine No. 598, however, for the Southern Railway, with driving-wheels 57 inches diameter and a boiler pressure of 200 pounds, has a maximum tractive power of 43,305 pounds, while engine No. 631, for the Chesapeake & Ohio, with 56-inch driving-wheels and a working pressure of 185 pounds, has a maximum tractive power of 38,055 pounds.

It is interesting to note that both engines are equipped with the Walschaerts valve gear, an evidence of the rapid development of the use of this design of valve motion. In 1904, at the time of the Louisiana Purchase Exposition at St. Louis, the Walschaerts valve gear was a new feature in American locomotive practice; and out of twelve locomotives exhibited by the same company at that exposition, only one—the Baltimore & Ohio Mallet compound—was equipped with this type of gear. At the present time the Walschaerts valve gear is used on almost all the great trunk lines in the country. The two engines represent two different arrangements of this gear. As the Chesapeake & Ohio engine is equipped with inside admission valves, the connection of the valve stem with the combination lever is below the radius bar, while on the engine for the Southern Railway, with balanced slide valves and outside admission, the connection is above the radius bar. In the Chesapeake & Ohio design the link is supported in a bracket bolted to the back of the guide-yoke, and the reverse shaft being located between the second and third drivers, the reverse shaft arm is directly connected with the radius bar by means of a slip joint. In the Southern

Fig. 1. Engine built by the American Locomotive Company for the Southern Railway, Jamestown Exposition.

Fig. 2. Engine built by the American Locomotive Company for the Chesapeake & Ohio Railroad, Jamestown Exposition.

Buffalo, Rochester & Pittsburg Railroad Decapod Locomotive.

Railway design, while the link is also carried in a casting bolted to the back of the guide-yoke, the reverse shaft is carried in bearings which form a part of the same casting, and the radius bar is connected to a backward extending arm of this shaft by means of a lifting link.

* * *

BUFFALO, ROCHESTER & PITTSBURG R. R. DECAPOD LOCOMOTIVE.

The description, specification and side elevation of a decapod locomotive, of which six have been built for the Buffalo, Rochester & Pittsburg R. R., were published in the May issue of RAILWAY MACHINERY. The accompanying photograph shows one of these heavy engines, which since has been completed. The American Locomotive Co. has given us some information regarding the service for which the locomotive is intended, as follows:

These engines are intended for pushing service and will operate between Clarion Junction and Freeman, a distance of 17 miles. The ruling grade between these points is 58 feet to the mile with numerous curves, the sharpest of which are 8 degrees. This grade controls the tonnage on north-bound freight business on this road. At the present time 3,350 M's (1,675 tons) are being handled up this grade with two consolidation engines, each with a tractive power of 38,000 pounds, one being used on the rear end as a pusher. The rating of the same class of consolidation power from Punxsutawney, Ernest or DuBois to the foot of the grade is 3,500 M's.

With the track improvements which are now in progress, it is expected that with the same class of consolidation engine it will be possible to handle 4,000 M's to the foot of the Clarion hill from either Punxsutawney, Ernest or DuBois, and the decapod engines here illustrated have been ordered in anticipation of these track improvements and are expected to handle a train of 5,000 M's up Clarion hill with a consolidation on the lead.

* * *

CAUSES OF LEAKS IN LOCOMOTIVE BOILER TUBES.—1.*

M. E. WELLS.†

In order to obtain some new information on this subject, we sent out, to foreign countries as well as to the principal railways of the United States, a list of questions concerning the causes of leaks in locomotive boiler tubes. We made a mistake in saying, in the letters to foreign railways, that the questions referred to iron and steel boiler tubes and tube-plates, as we used no other kind in the United States. On account of this, a number replied that they could give us no information, since they use only copper for fire-boxes and tube-plates, and, in some cases, copper and brass tubes. The copper and brass tubes, however, are being replaced with soft steel. At first these steel tubes were reinforced with copper safe-ends at the fire-box tube-plate, but the use of these is being discontinued, and they are setting the soft steel tube directly into the copper tube-plate.

Some of the foreign railways, more thoughtful than myself, gave quite full answers to the questions, realizing that the causes of leaks in locomotive boiler tubes are practically the same, whether the tube-plate is of copper or of steel; and it is interesting to note that if the causes for leaks, given by each railroad, were put on separate slips of paper, without the name of the road, it would be impossible to separate the foreign lists from those sent in by our own railroads, so nearly identical are the causes given.

For convenience of discussion, our subject can be divided into two general heads:

1. Those leaks due to mechanical causes.
2. Those leaks due to variations in temperature.

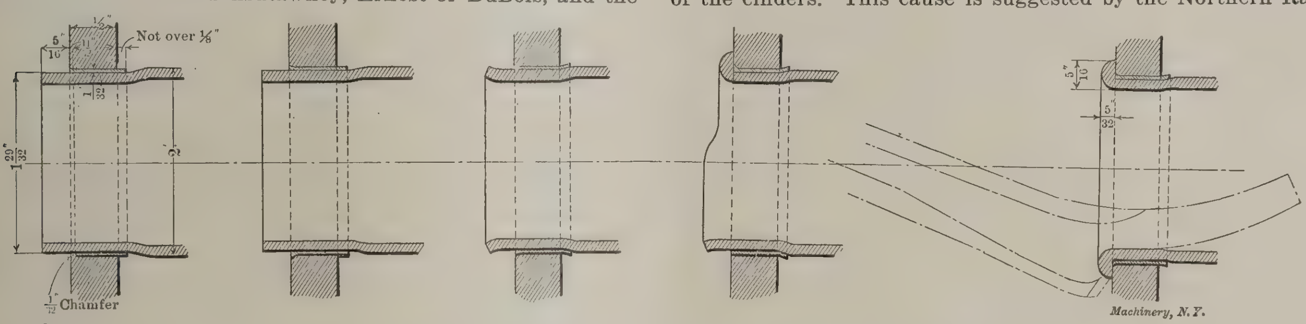
The first can be divided into four subheads:

a. Defective work at the time of first setting the tubes. This phase of the subject is receiving so much attention, and the practice of setting tubes is so uniform and well understood all over the United States, that we scarcely feel it necessary to go further into it than to consider its effect on leakage. This, as a cause of tube leakage, is very slight, because almost any kind of a job done by an apprentice boy in the front end will hold from one shopping of an engine to the next, while a much better job done by a skilled mechanic gives practically no trouble, and really never causes a delay, when done on the upper tubes in the fire-box; and yet the most skillful job that it is possible for a skilled mechanic to do on the bottom tubes in the fire-box will hold, at most, but a few days, in our largest boilers.

b. Poor hurry-up work in running repairs is a much more prolific source of trouble than any one of the other causes given under the head of "mechanical," and yet the remedy is quickly stated—take time to do it well.

c. Vibration of the tubes. Much stress is put upon this by some, especially if long tubes are used. That tubes do vibrate vertically there is no doubt in my mind since finding in a boiler a tube, 19 feet long, set so close to the bottom of the shell that a rivet head wore a hole through the tube. This vibration, as a cause of leakage, cannot be considered very important, because if it were, this action would certainly loosen the tubes in the smoke-box tube-plate.

d. Wearing out of the tube ends by the abrasive action of the cinders. This cause is suggested by the Northern Railway of France, and the same, or a similar condition, is referred to by the Pennsylvania Railroad, as "burnt-off and cracked beads, due to shallow fire-boxes." We hope to be able to show further on in this discussion that the real cause of this condition is internal in the boiler, rather than external, and that, really, this cause should be classified under the second general head, namely: leaks due to variations of temperature.



Operation 4. Operation 5. Operation 6. Operation 7.

Fig. 1. Union Pacific Railroad Method of Setting Boiler Tubes.

Methods of Setting Flues.

Before leaving this phase of the subject, and by way of comparative interest, we wish to show illustrations of tube-setting as reported by various countries. The method of setting tubes, with us, is so uniform, that I reproduce here an illustration and description of the process used by the Union Pacific Railroad, Fig. 1, as being practically standard for the United States.

1. All scale must be removed from the flue hole by small air drill with small emery wheel on shaft of drill.
2. All scale must be removed from end of flue. This can be done by holding a square file on end of flue while being cut to length and flue is revolving.
3. Copper of proper thickness inserted and expanded in flue hole. Edge of copper should be 1/32 inch from face of flue sheet.
4. Flue inserted and pinned out.
5. Rolled with roller expander.
6. Expanded with Prosser sectional expander.
7. Beaded with standard beading tool.

There is some difference of opinion among us as to when the rollers should be used, whether before or after the sectional expander (Prosser); and some roads do not use rollers in either first setting of tubes or in running repairs, while some use them in first setting, but never in running repairs. However, these slight variations in method are of very little

* Paper presented at the annual convention of the American Railway Master Mechanics' Association, at Atlantic City, N. J., June, 1907.
† Assistant master mechanic, Wheeling & Lake Erie R. R.

importance. Personally, I have never objected to the roller expanders, if they are used only to tighten the tube in the tube-sheet; but when they are carelessly used to wear out and roll thin the material, there is serious objection to their use. In England, France and Germany only roller expanders are used, the sectional, or Prosser expander, never being mentioned. Of the American railroads reporting, 60 per cent favored the sectional expander, and 40 per cent the roller expander.

The Lancashire & Yorkshire Railway of England reports the use of an electric motor for rolling tubes. My experience has shown this method very disastrous to tubes, because the operator cannot tell when to stop, and the result is that tubes are actually rolled thin and worn out at the first setting. Air can be used for "prossering" and beading, but a motor for rolling, we believe, should never be used. Rolling, if done at all, should be done by hand and by a mechanic.

This same road sent a drawing, Fig. 2, showing the tube and ferrule at the fire-box end. The ferrules are welded and made from Swedish high-carbon steel. Those made of solid drawn weldless tubing were found to be too soft. The ferrules are driven in by an ordinary drift. The fire-box tube-plate is of copper, one inch thick, while the front tube-plate is of steel, ⅞ inch thick. This road does not bead over the end of the tube, while the North-Eastern Railway of England does.

The London & South-Western Railway reports that tubes in the fire-box are expanded in the tube-plate by a roller expander, and that the tubes in the bottom half are beaded over and ferruled.

The Great Eastern Railway of England reports tubes expanded with a roller expander and beaded, no ferrules being used.

The Southern Railway of France says that its method consists in rolling and beading over the end of the tube, and then putting in a ferrule. When necessary to replace ferrules, it sometimes replaces the ordinary ferrule with one having a collar or bead.

The Northern Railway of France says: "Our tubes of soft steel, 70 millimeters (2.75 inches) diameter, are swedged to 66 millimeters (2.6 inches), and are rolled and beaded in the copper tube-plate as shown." See Fig. 3.

The French have the same trouble we all have with the tube-holes getting out of round, especially in the upper corners. This is the best kind of evidence that they have to roll and re-roll their tubes frequently, to keep them tight, as we do. In the lower tubes, where they leak most often and therefore require more frequent rolling, they swedge the tube ends down to 60 millimeters (2.36 inches) instead of 66 millimeters (2.6 inches), thereby giving more metal in the bridges. The bridges for 2.75-inch tubes are from 0.66 of an inch to 0.79 of an inch, not counting the swedging.

The Eastern Railway of France reported in 1895 to the International Railway Congress as follows: "All tubes are expanded with Dudgeon's apparatus (*i.e.*, rolled) and riveted or beaded. Ferrules are not used in steel tubes, but are still used in brass tubes." However, now, in 1907, it writes: "We have only to report the use of steel tubes replacing brass tubes, and in the greater part of our new engines Serve tubes are being used. Our tubes are rolled and fortified by a steel conical ring (ferrule)." While some of the railways of Europe are getting away from the use of the steel ferrule, here is a case where they have gone back to it.

The Royal Bavarian States Railroad uses a copper safe-end on an iron tube. Fig. 4. It is simply rolled and beaded in the fire-box, and only rolled in the front end. Note the increased strength of the safe end, and the way shimming in the front end is avoided.

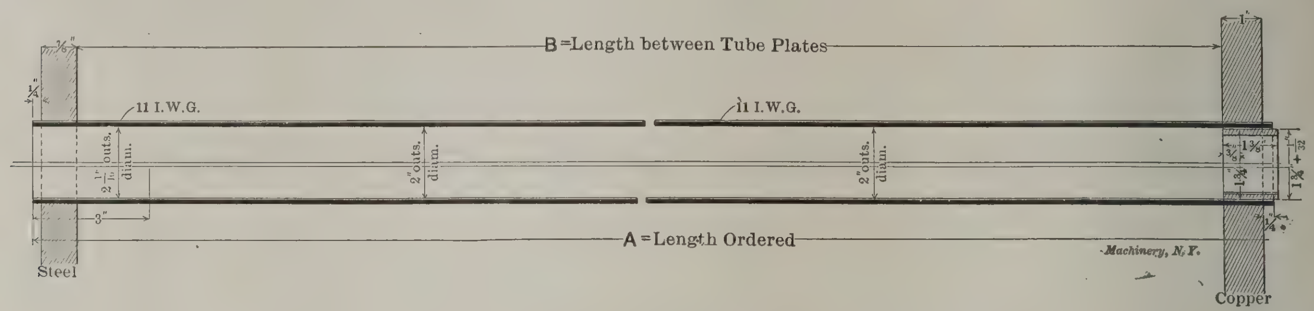


Fig. 2. Method of Lancashire & Yorkshire Railway, showing Tube and Ferrules at Fire-box End.

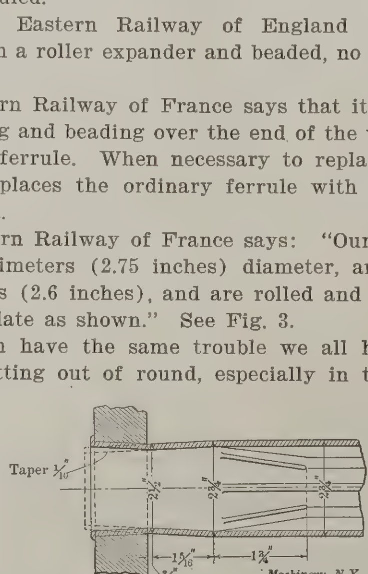


Fig. 3. Boiler Tube Setting, Northern Railway of France.

Under the second general head of our subject, "Leaks Due to Variations of Temperature," we have two subheads: *a.* Causes of leaks due to equal variations of temperature; and *b.* Those due to unequal variations of temperature.

Tube Ends not Loosened by Even Heating and Cooling.

It can be clearly demonstrated that small damage is done to boiler tube joints when they are subjected to equal variations of temperature; that is, tube ends, fitted in a tube-plate, can be heated up and cooled down a great number of times, and not become loosened, if all connected parts are heated up and cooled down uniformly. By way of experiment, and to determine if the uniform heating up and cooling down loosens a tube in a tube-plate, we have made the following test: A piece of 2¼-inch tube was set in a ½-inch tube-plate in the regular way. In order to be able to detect the slightest loosening, the bead was chipped off and dressed down so that the joint between the tube and the copper shim could be periodically inspected by means of a strong magnifying glass. We also used the hammer test. For heating, we used a gas oven, the average temperature of which was about 450 degrees F. This temperature was determined by means of fusible metal of known fusing point. This test was carried on through a period of about sixty days, and in that time this plate was heated up and cooled down an average of twice in twenty-four hours, through a range of about 400 degrees F. In spite of the 120 heatings and coolings, the tube shows no signs whatever of loosening. From this we conclude that it takes something more than the uniform heating up and cooling down of a tube to loosen it in the tube-plate. This we have also learned in a practical way from the fact that the top tubes in a fire-box give practically no trouble from leaking, as compared with the bottom tubes, and yet these top tubes are subjected to slightly higher temperatures than the bottom tubes.

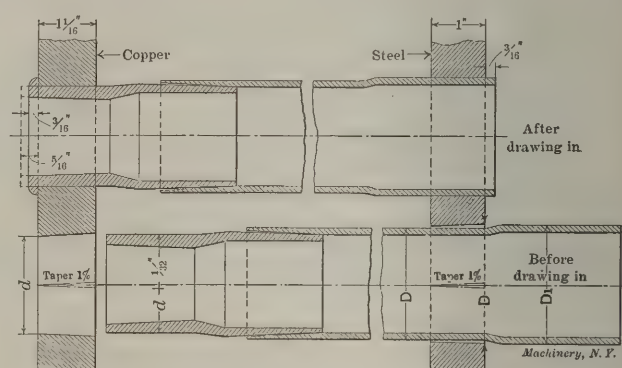


Fig. 4. Boiler Tube Setting, Bavarian State Railways.

CALCULATING THE DIMENSIONS OF WORM GEARING.*

RALPH E. FLANDERS.†

This article makes no pretense of giving any new information, nor of treating the subject from a new standpoint. It is intended to be simply a compilation of rules for the calculation of the dimensions of worm gearing, expressed with as much simplicity and clearness as the writer can attain to.

No attempt has been made to give rules for estimating the strength or durability of worm gearing, although the question of durability, especially, is the determining factor in the design of worm gearing. If the worm and wheel are so proportioned as to have a reasonably long life under normal working conditions, it may be taken for granted that the teeth are strong enough for the load they have to bear. No simple rules have ever been proposed, so far as the writer is aware, for proportioning worm gearing to suit the service it is designed for. Judgment and experience are about the only factors the designer has for guidance. In Europe, a number of builders are regularly manufacturing worm drives, guaranteed for a given horse-power at a given speed. The dimensions of these drives are not made public, however; they would doubtless be of great value for purposes of comparison if they could be obtained. In the absence of these or other practical data, the writer has dodged the issue entirely.

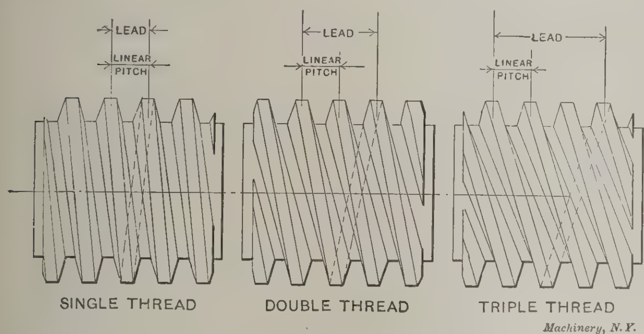


Fig. 1. Distinction between the Terms Lead and Linear Pitch as Applied to Worms.

Definitions and Rules for Dimensions of the Worm.

In giving names to the dimensions of the worm there is one point in which there is sometimes confusion. This relates to the distinction between the terms "pitch" and "lead." In this article we will follow the nomenclature indicated in Fig. 1. Here are shown three worms, the first single-threaded, the second double-threaded, and the last triple-threaded. As shown, the word "lead" is assumed to mean the distance which a given thread advances in one revolution of the worm, while by "pitch," or more strictly "linear pitch," we mean the distance between the centers of two adjacent threads. As may be clearly seen, the lead and linear pitch are equal for a single-threaded worm. For a double-threaded worm the lead is twice the linear pitch, and for a triple-threaded worm it is three times the linear pitch. From this we have:

RULE 1. *To find the lead of a worm, multiply the linear pitch by the number of threads.*

It is understood, of course, that by the number of threads is meant, not the number of threads per inch, but the number of threads in the whole worm—one, if it is single-threaded, four, if it is quadruple-threaded, etc. Rule 1 may be transposed to read as follows:

RULE 2. *To find the linear pitch of a worm, divide the lead by the number of threads.*

The standard form of worm thread, measured on an axial section as shown in Fig. 2, has the same dimensions as the standard form of involute rack tooth of the same linear or circular pitch. It is not of exactly the same shape, however, not being rounded at the top nor provided with fillets. The thread is cut with a straight-sided tool, having a square, flat end. The sides have an inclination with each other of 29 degrees, or 14½ degrees with the center line. The following rules give the dimensions of the teeth on an axial section for various linear pitches. For nomenclature, see Fig. 2.

RULE 3. *To find the whole depth of the worm tooth, multiply the linear pitch by* 0.6866.

RULE 4. *To find the width of the thread tool at the end, multiply the linear pitch by* 0.31.

RULE 5. *To find the addendum or height of worm tooth above the pitch line, multiply the linear pitch by* 0.3183.

RULE 6. *To find the outside diameter of the worm, add together the pitch diameter and twice the addendum.*

RULE 7. *To find the pitch diameter of the worm, subtract twice the addendum from the outside diameter.*

RULE 8. *To find the bottom diameter of the worm, subtract twice the whole depth of tooth from the outside diameter.*

RULE 9. *To find the helix angle of the worm and the gashing angle of the worm-wheel tooth, multiply the pitch diameter of the worm by 3.1416, and divide the product by the lead; the result is the cotangent of the tooth angle of the worm.*

Rules for Dimensioning the Worm-wheel.

The dimensions of the worm-wheel, named in the diagram shown in Fig. 3, are derived from the number of teeth determined upon for it, and the dimensions of the worm with which it is to mesh. The following rules may be used:

RULE 10. *To find the pitch diameter of the worm-wheel, multiply the number of teeth in the wheel by the linear pitch of the worm, and divide the product by 3.1416.*

RULE 11. *To find the throat diameter of the worm-wheel, add twice the addendum of the worm tooth to the pitch diameter of the worm-wheel.*

RULE 12. *To find the radius of curvature of the worm-wheel throat, subtract twice the addendum of the worm tooth from half the outside diameter of the worm.*

The face angle of the wheel is arbitrarily selected; 60 degrees is a good angle, but it may be made as high as 80 or even 90 degrees, though there is little advantage in carrying the gear around so great a portion of the circumference of the worm, especially in steep pitches.

RULE 13. *To find the diameter of the worm-wheel to sharp corners, multiply the throat radius by the cosine of half the face angle, subtract this quantity from the throat radius, multiply the remainder by 2, and add the product to the throat diameter of the worm-wheel.*

If the sharp corners are flattened a trifle at the tops, as shown in Figs. 3 and 5, this dimension need not be figured, "trimmed diameter" being easily scaled from an accurate drawing of the gear.

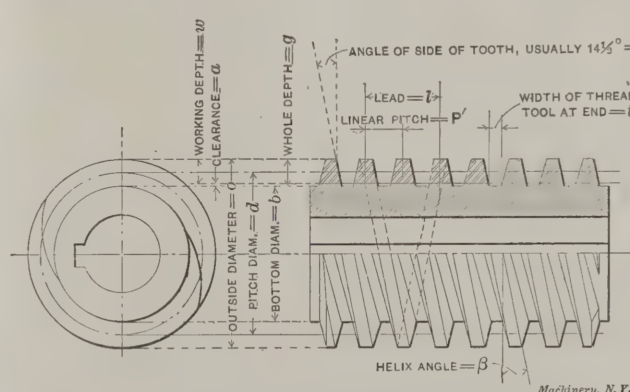


Fig. 2. Nomenclature of Worm Dimensions.

There is a simple rule which, rightly understood, may be used for obtaining the velocity ratio of a pair of gears of any form, whether spur, spiral, bevel, or worm. The number of teeth of the driven gear, divided by the number of teeth of the driver, will give the velocity ratio. For worm gearing this rule takes the following form.

RULE 14. *To find the velocity ratio of a worm and worm-wheel, divide the number of teeth in the wheel by the number of threads in the worm.*

Be sure that the proper meaning is attached to the phrase "number of threads" as explained above under Rule 1. The revolutions per minute of the worm, divided by the velocity ratio, gives the revolutions per minute of the worm-wheel.

RULE 15. *To find the distance between the center of the worm-wheel and the center of the worm, add together the pitch diameter of the worm and the pitch diameter of the worm-wheel, and divide the sum by 2.*

RULE 16. *To find the pitch diameter of the worm, subtract the pitch diameter of the worm-wheel from twice the center distance.*

* The following articles on worm gearing have previously appeared in MACHINERY: Worm Gearing, December, 1902, engineering edition; Theoretical Efficiency of Worm Gearing, December, 1903, engineering edition; An Example of Worm Gearing, June, 1905; The Worm Gear, October, 1905, engineering edition; On the Location of the Pitch Circle in Worm Gearing, November, 1905.

† Address: 107 E. 23d St., New York, N. Y.

The worm should be long enough to allow the wheel to act on it as far as it will. The length of the worm required for this may be scaled from a carefully-made drawing, or it may be calculated by the following rule:

RULE 17. *To find the minimum length of worm for complete action with the worm-wheel, subtract four times the addendum of the worm thread from the throat diameter of the wheel, square the remainder, and subtract the result from the square of the throat diameter of the wheel. The square root of the result is the minimum length of worm advisable.*

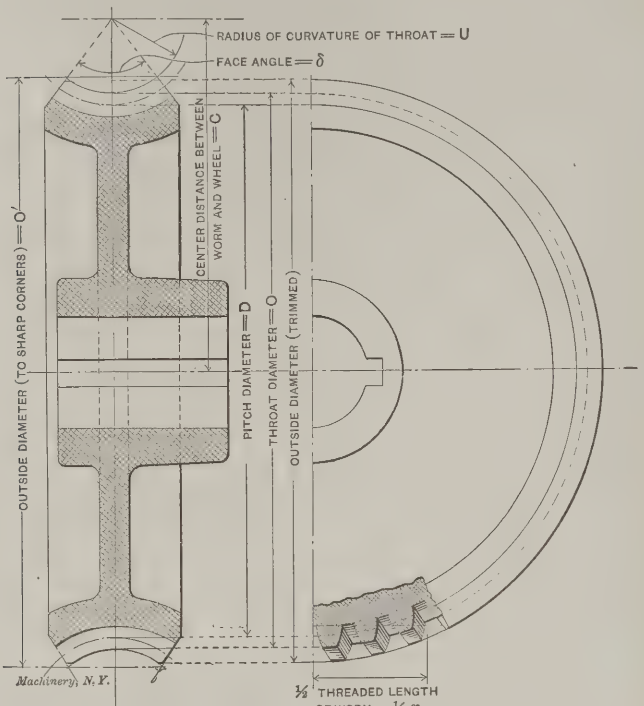


Fig. 3. Nomenclature of Worm-Wheel Dimensions.

The length of the worm should ordinarily be longer than the dimension thus found. Hobs, particularly, should be long enough for the largest wheels they are ever likely to be called upon to cut.

Departures from the Above Rules Sometimes Advisable.

The throat diameter of the wheel and the center distance may have to be altered in some cases from the figures given by the preceding rules. If worm-wheels with small numbers of teeth are made to the dimensions given, it will be found that the flanks of these teeth will be partly cut away by the tops of the hob teeth, so that the full bearing area is not available. The matter becomes serious when there are less than 25 teeth in the worm-wheel. There are two ways of avoiding the difficulty. One of them is to increase the included angle of the sides of the thread tool. This departure from standard form, however, may be avoided by an increase in the throat diameter of the wheel, and consequently in the center distance. Discussions of this subject will be found in "Formulas in Gearing," and "Practical Treatise on Gearing," both published by the Brown & Sharpe Mfg. Co., Providence, R. I.

On the other hand, some designers claim to get better results in efficiency and durability by making the throat diameter of the worm-wheel *smaller* than standard, where it is possible to do so without too much under-cutting. For a discussion of this subject, see the articles by various writers, mentioned in the foot note on the preceding page. In no case, however, should the throat diameter ever be made so small as to produce more interference than is met with in a standard 25-tooth worm-wheel.

Two Applications of Worm Gearing.

Worm-wheels are used for two purposes. They may be employed to transmit power where it is desired to make use of the smoothness of action which they give, and the great reduction in velocity of which they are capable; instances of this application of worm gearing are found in the spindle drives of gear cutters and other machine tools. They are also used where a great increase in the effective power is required; in this case advantage is generally taken of the possibility of making the gearing self-locking. Such service is usually intermittent or occasional, and the matter of waste of power is not of so great importance as in the first case. Examples of this application are to be found in the adjustments of a great many machine tools, in training and elevating gearing for ordnance, etc. In the case of elevator gearing and worm feeds for machinery, the functions of the gearing are, in a measure, a combination of those in the two applications.

Examples of Worm Gearing Figured from the Rules.

To show how the rules given above may be applied, we will work out two examples. The first of these is for a light machine tool spindle drive, in which power is to be transmitted continuously. It is determined that the velocity ratio shall be 8 to 1, and that the proper linear pitch to give the strength and durability required shall be about ¾ inch; the center distance is required to be 5 inches exactly. This case comes under the first of the two applications just described.

Assume, for instance, 32 teeth in the wheel, and a quadruple-thread worm. We will figure the gearing with these assumptions, and see if it appears to have practical dimensions.

The pitch diameter of the worm-wheel by Rule 10 is found to be

$$\frac{32 \times ¾}{3.1416} = 7.6394 \text{ inches.}$$

The pitch diameter of the worm by Rule 16 is found to be

$$(2 \times 5) - 7.6394 = 2.3606 \text{ inches.}$$

The addendum of the worm thread by Rule 5 is found to be

$$0.3183 \times ¾ = 0.2387 \text{ inch.}$$

The outside diameter of the worm by Rule 6 is found to be

$$2.3606 + (2 \times 0.3183) = 2.8380 \text{ inches.}$$

For transmission gearing the angle of inclination of the worm thread should be not less than 18 degrees or thereabouts, and the nearer 30 or even 40 degrees it is, the more efficient will it be. From Rule 1 we find the lead to be $4 \times ¾ = 3$ inches.

The helix angle of the worm thread is found from Rule 9, $2.3606 \times 3.1416 \div 3 = 2.4722 =$ cot. 22 degrees, approximately. This angle will give fairly satisfactory results. The calculations are not carried any further with this problem, whose other dimensions are determined from those just found. In the following case, however, all the calculations are made.

For a second problem let it be required to design worm feed gearing for a machine to utilize a hob already in stock. This hob is double-threaded, ½ inch linear pitch, and 2½ inches diameter. The center distance of the gearing is immaterial, but it is decided that the worm-wheel ought to have

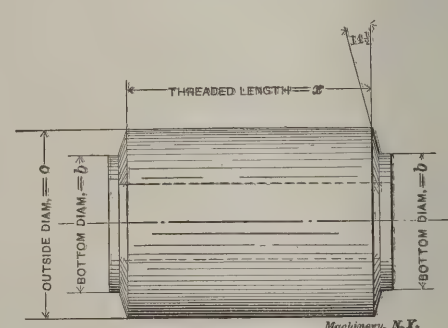


Fig. 4. Shape of Blank for Worm.

about 45 teeth to bring the ratio right. The only calculations made are those necessary for the dimensions which would appear on the shop drawing.

To find the lead, use Rule 1: $0.5 \times 2 = 1.0$ inch.

To find the whole depth of the worm tooth, use Rule 3: $0.5 \times 0.6866 = 0.3433$ inch.

To find the addendum, use Rule 5: $0.5 \times 0.3183 = 0.15915$ inch.

To find the pitch diameter of the worm, use Rule 7: $2.5 - 2 \times 0.15915 = 2.1817$ inches.

To find the bottom diameter of the worm, use Rule 8: $2.5 - 2 \times 0.3433 = 1.8134$ inch.

To find the gashing angle of the worm-wheel, use Rule 9: $2.18 \times 3.14 \div 1 = 6.849 =$ cot. 8 degrees 20 minutes, about.

To find the pitch diameter of the worm-wheel, use Rule 10: $45 \times 0.5 \div 3.1416 = 7.1620$ inches.

To find the throat diameter of the worm-wheel, use Rule 11: $7.1620 + 2 \times 0.15915 = 7.4803$ inches.

To find the radius of the throat of the worm-wheel, use Rule 12: $(2.5 \div 2) - (2 \times 0.15915) = 0.9317$ inch.

The angle of face may be arbitrarily set at, say, 75 degrees, in this case. The "trimmed diameter" is scaled from an accurate drawing, and proves to be 7.75 inches.

To find the distance between centers of the worm and wheel, use Rule 15: $(2.1817 + 7.1620) \div 2 = 4.6718$ inches.

To find the minimum length of threaded portion of the worm, use Rule 17: $7.4803 - 4 \times 0.15915 = 6.8437$

$$\sqrt{7.4803^2 - 6.8437^2} = 3.04 \text{ inches.}$$

It will be noted that the ends of the threads in Fig. 2 are trimmed at an angle instead of being cut square down, as in Fig. 1. This gives a more finished look to the worm. It is easily done by applying the sides of the thread tool to the blank just before threading, or it may be done as a separate operation in preparing the blank, which will in either case have the appearance shown in Fig. 4. The small diameters at either end of the blank in Fig. 4 should, in any event, be turned exactly to the bottom diameter shown in Fig. 2, and obtained by Rule 8. This is of great assistance to the man who threads the worm, as he knows that the threads are sized properly as soon as he has cut down to this diameter with the end of his thread tool. This always supposes, of course, that the thread tool is accurately made.

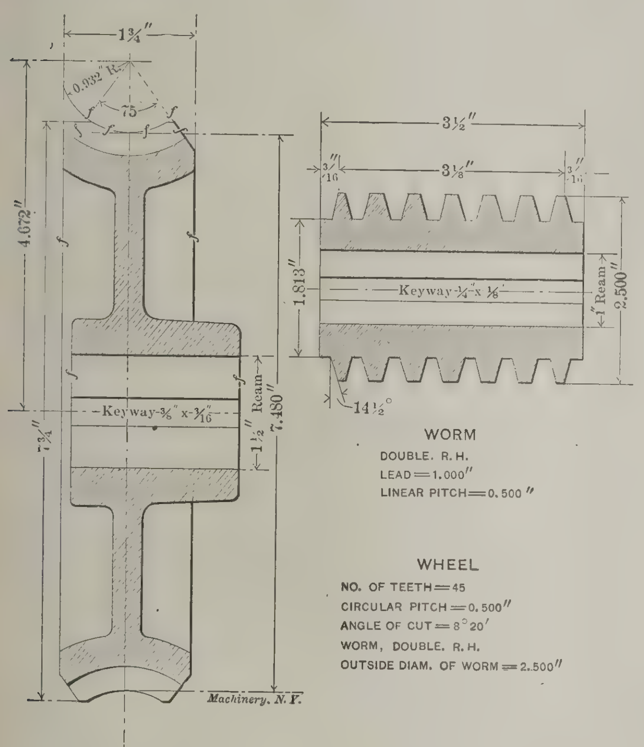


Fig. 5. Model Drawing of Worm and Worm-wheel.

A model drawing of a worm-wheel and worm, properly dimensioned, is shown in Fig. 5. This drawing follows, in general, the model drawings shown by Mr. Burlingame in the August, 1906, issue of MACHINERY, taken from the drafting-room practice of the Brown & Sharpe Mfg. Co. In cases where the worm-wheel is to be gashed on the milling machine before hobbing, the angle at which the cutter is set should also be given. This is the same as the angle of worm tooth found by Rule 9. In cases where the wheel is to be hobbed directly from the solid by a positively geared hobbing machine, this information is not needed. It might be added that it is impracticable with worm-wheels having less than 16 or 18 teeth to gash the wheel, and then hob it when running freely on centers, if the throat diameter has been determined by Rule 11.

Formulas for the Design of Worm Gearing.

For the convenience of those who prefer to have their rules compressed into formulas, they are so arranged below. The reference letters used are as follows:

N = number of teeth in worm-wheel.
n = number of teeth or threads in worm.
P' = circular pitch of wheel and linear pitch of worm.
l = lead of worm.
g = whole depth of worm tooth.
t' = width of the thread tool at the end.
s = addendum or height of worm tooth above pitch line.
o = outside diameter of the worm.
d = pitch diameter of the worm.
b = bottom or root diameter of the worm.
β = helix angle of worm and gashing angle of wheel.
δ = face-angle of worm-wheel.
D = pitch diameter of the worm-wheel.
O = throat diameter of the worm-wheel.
O' = diameter of the worm-wheel to sharp corners.
U = radius of curvature of the worm-wheel throat.
R = velocity ratio.
C = distance between centers.
x = threaded length of worm.

$$l = n \times P'. \tag{1}$$
$$P' = l \div n. \tag{2}$$
$$g = 0.6866\,P'. \tag{3}$$
$$t' = 0.31\,P'. \tag{4}$$
$$s = 0.3183\,P'. \tag{5}$$
$$o = d + 2s. \tag{6}$$
$$d = o - 2s. \tag{7}$$
$$b = o - 2g. \tag{8}$$
$$\text{Cotangent } \beta = 3.1416d \div l. \tag{9}$$
$$D = N P' \div 3.1416. \tag{10}$$
$$O = D + 2s. \tag{11}$$
$$U = \tfrac{1}{2}o - 2s. \tag{12}$$
$$O' = 2(U - U \cos. \delta/2) + O. \tag{13}$$
$$R = N \div n. \tag{14}$$
$$C = (D + d) \div 2. \tag{15}$$
$$d = 2C - D. \tag{16}$$
$$\text{Minimum value of } x = \sqrt{O^2 - (O - 4s)^2}. \tag{17}$$

* * *

THE AUTOMOBILE AS THE PIONEER OF CIVILIZATION.

It is a curious fact that the automobile is put to its best practical use, as it seems, not in the countries of the highest development in civilization, but in the way-off corners of the world, where one would hardly expect to meet with so recent an indication of the presence of civilized man. Thus, in Madagascar there has been regular freight and passenger traffic over a route over 200 miles long, all since June, 1903. The motor cars use two days to cover the distance mentioned. Even in Tunis has a long-distance motor-car route been established, giving regular service over a line 80 miles long. The use of motor cars for this purpose is rather limited in this country, although they have been employed to some extent in the newly developed mining regions in the arid southwest, where there is considerable difficulty in the employment of animals, owing to the heat and lack of water. One of these routes, that connecting the Bull Frog and Goldfield mining districts with the nearest railroad station, adopted a novel scheme for monopolizing the highway built for the purpose. Over the gullies, which had to be bridged, the cars are run on stringers, with suitable guides to prevent them from running off. There is no flooring to these bridges, so that it is impossible for a horse-drawn vehicle to cross.

* * *

The *Times Engineering Supplement* gives some details about a remarkable garage, which are of interest mostly as indicative of the enormous growth the automobile business has had abroad for commercial purposes. The garage referred to is to be erected in London and is to accommodate 960 motor cabs. One of the most interesting details is the safety arrangement for the petrol or gasoline. While the building is built wholly of fire-proof materials, containing no wood, but only steel protected by concrete, the petrol storage, designed to contain 3,200 gallons, would in itself constitute an element of danger. This storage has iron doors and fireproof partitions, and the roof is so constructed that, were a fire to occur, a layer of sand weighing 62 tons would at once descend bodily and extinguish any fire in the petrol.

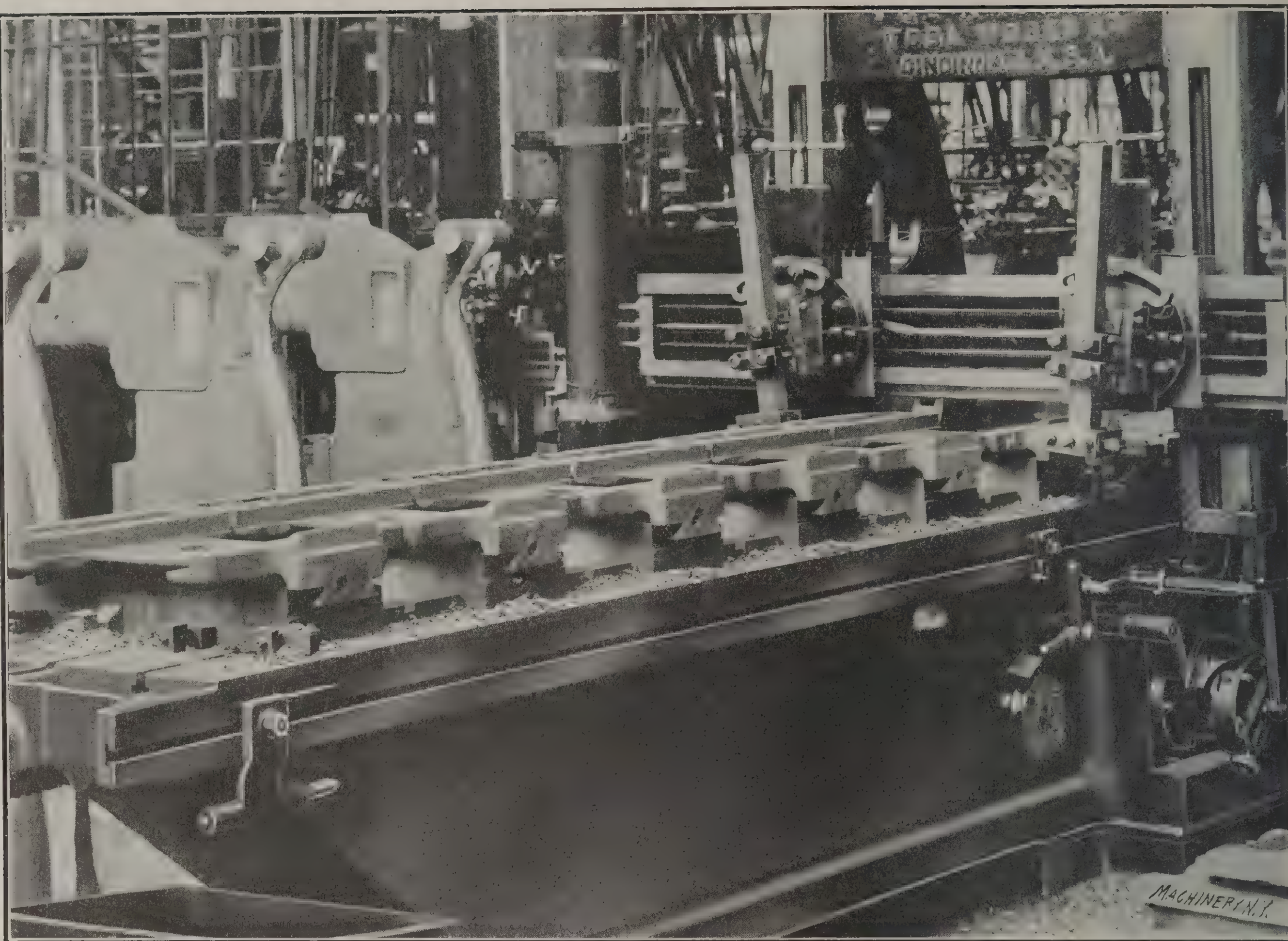


Fig. 1. Planing Lathe Saddles in Gangs.

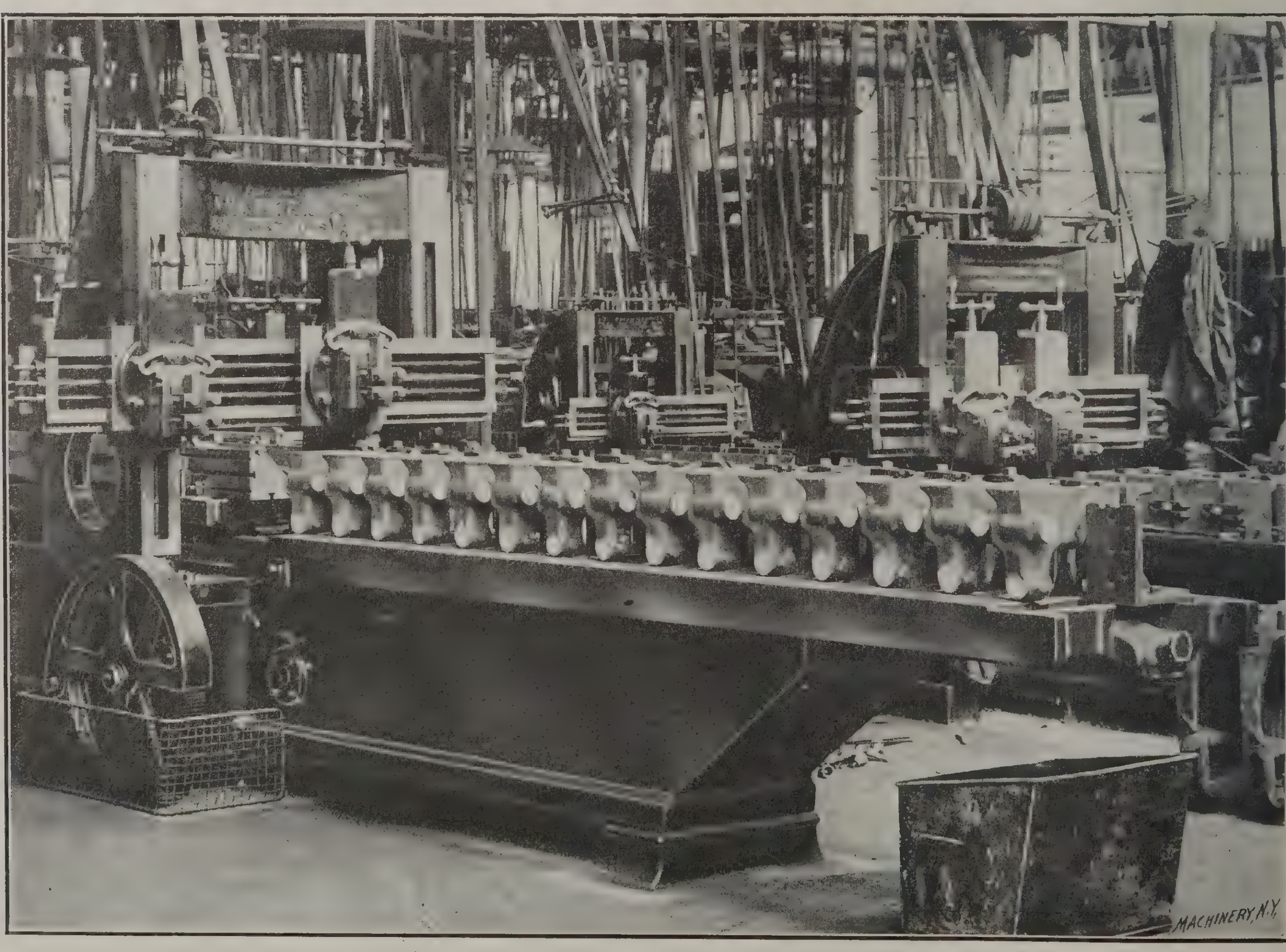


Fig. 2. Planing Aprons for the Saddles shown in Fig. 1.

ADVANCED BRITISH MANUFACTURING METHODS.

The accompanying half-tone illustrations show seven interesting examples of repetition work in machine tool manufacturing, taken from the well-known works of Alfred Herbert, Ltd., Coventry, England. In the March and April issues of MACHINERY half-tones were shown illustrating some structural features of the new Edgwick works of this concern at Coventry, which may be regarded as representative of advanced machine shop construction abroad. It will be admitted readily enough that the accompanying cuts, showing quantity production work, illustrate practice equal in most respects to the best methods pursued by leading American tool builders.

Fig. 1 shows the planing of lathe saddles in gangs of six, each casting being held in a dove-tail slotted jig in which the top guide of the carriage is chucked.

Fig. 2 shows the planer working on fifteen aprons for the lathe saddles illustrated in Fig. 1. In this case the aprons are simply chucked on the table using ordinary appliances, no jigs whatever being employed.

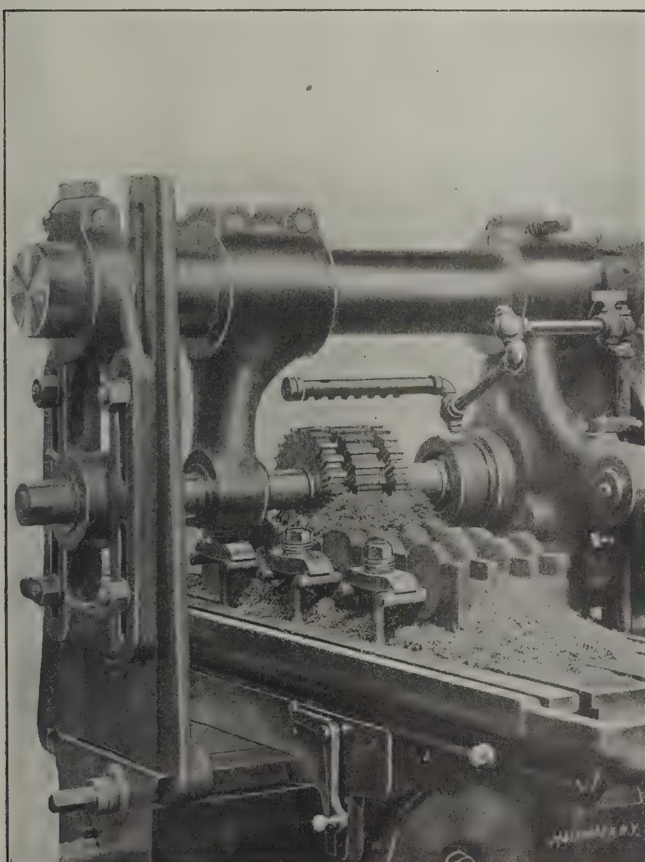


Fig. 3. Milling Toggle Levers for Turret Lathe Chucks.

Fig. 6 shows the planing of heads of small turret or "capstan" lathes, as they are known in British practice. In this operation fourteen heads are planed at once, two strings of seven each being ranged on the table. Here also there are no jigs used, as the nature of the work does not require it and, moreover, the irregularity of castings usually makes it the best practice to accommodate the casting to the finished requirements in the first operation, using the planed surfaces as gage points for determining the other dimensions in the succeeding operations.

Fig. 7 shows twenty-six cut-off slides for the Herbert hexagon turret lathe, these being in two strings of thirteen each. A large number of the slides are lying on the floor in front of the planer.

The same practice of grouping work in gangs is followed in milling machine work, and Fig. 3 is one illustration of the practice, showing the milling of toggle levers for the chuck of the Herbert hexagon turret lathe. Fig. 4 is an example of index milling, the work being the index disks for turrets. These are strung together on an arbor, and are indexed by the simple device shown on the front.

Fig. 5 illustrates the gang method of milling the conical holders used in the chuck of the Herbert turret lathe. In this case four saws are used at once and four holders are indexed simultaneously, the holders being held so that they are retained in position even after being slitted completely apart.

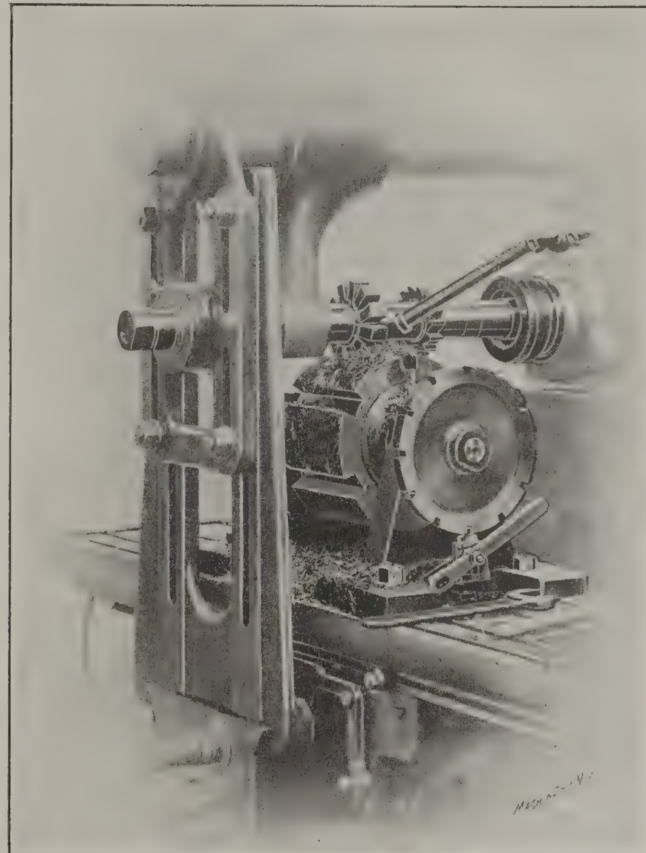


Fig. 4. Milling Index Disks for Turrets.

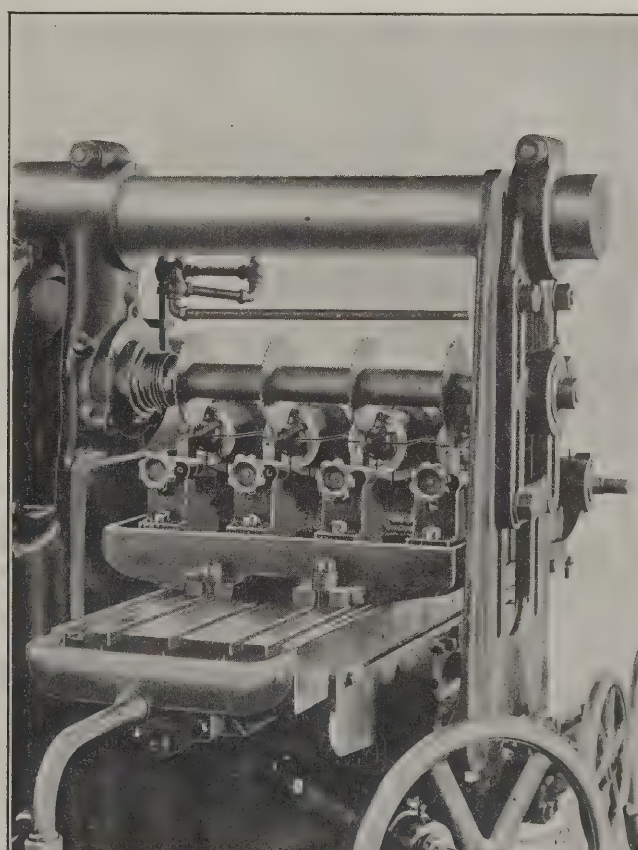


Fig. 5 Slitting Conical Holders used in Turret Lathe Chucks.

The pattern or "dummy" casting for setting planer tools, which is so much used in American practice on similar work, is not shown in use in any of these examples. This seems somewhat strange, for the use of the pattern is a great timesaver in the setting of the tools.

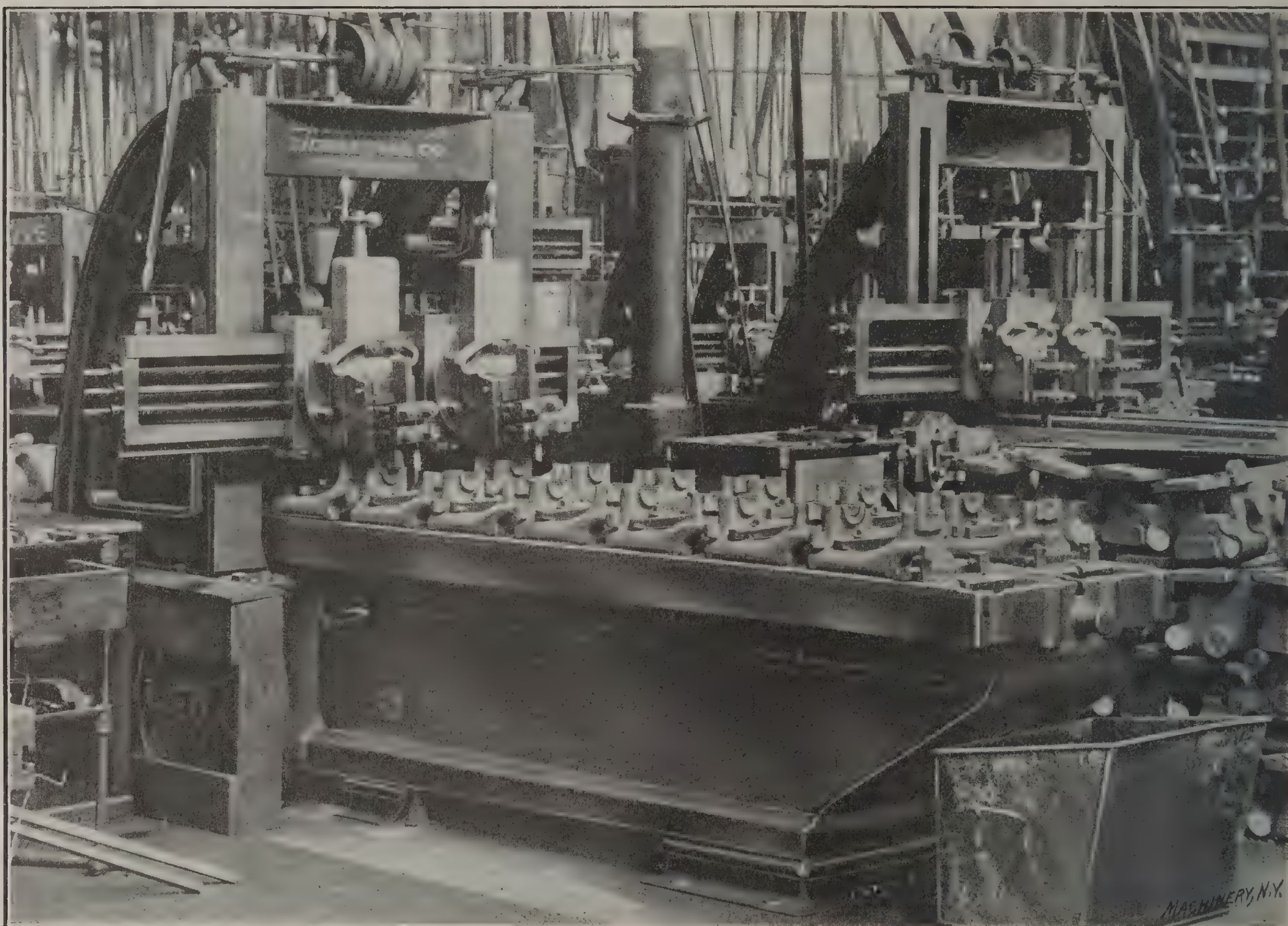


Fig. 6. Planing Heads for Small Turret Lathes.

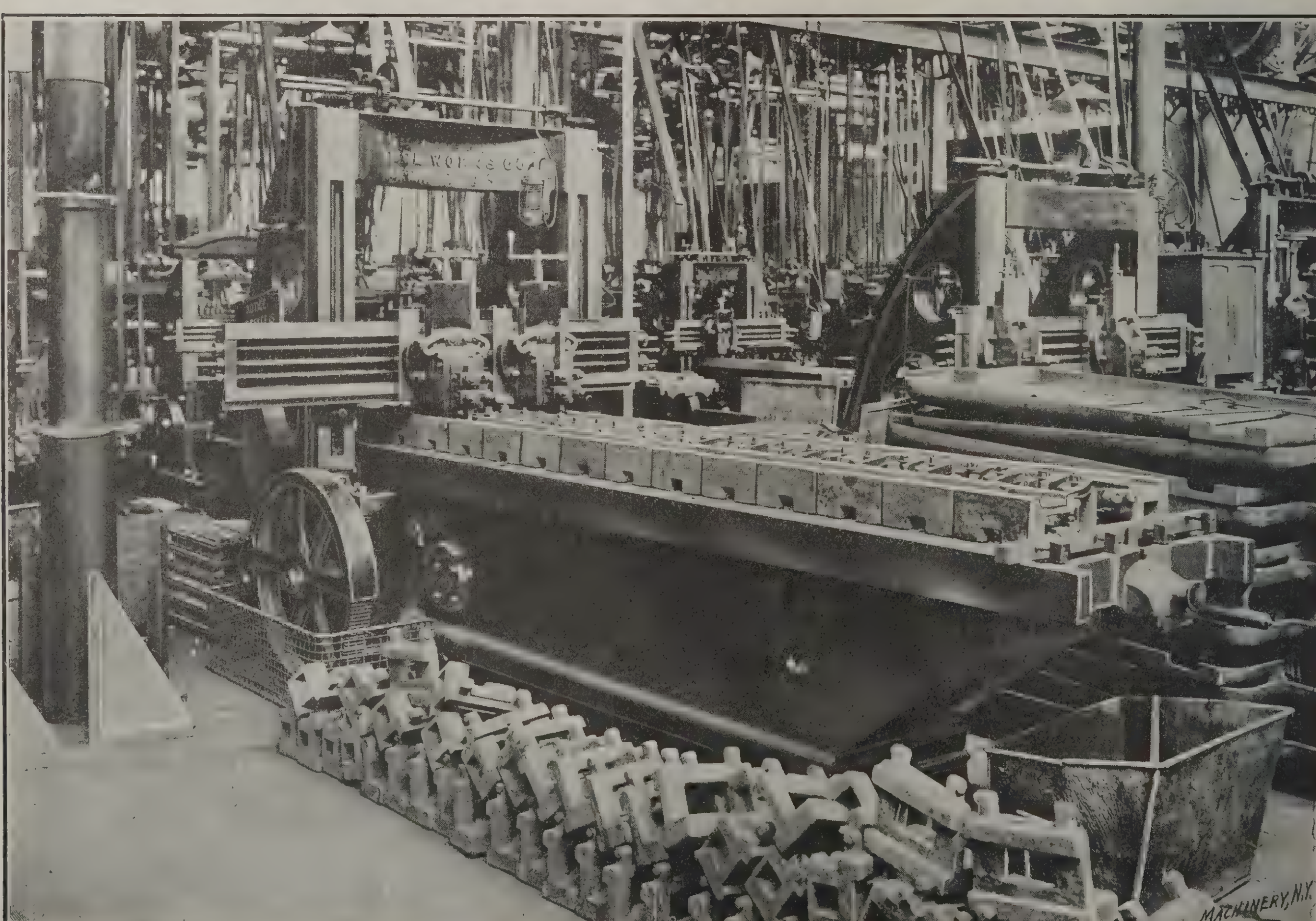


Fig. 7. Planing Cutting Off Slides for Turret Lathes.

ROTARY ENGINES.

W. H. BOOTH.*

Next to perpetual motion machines, the rotary engine is the favorite hunting ground of the born inventor. It often gives one a pang of regret to see the enormous ingenuity of the men who bring forth rotary engines, and yet only a fraction of the total number invented ever comes within one man's ken. I should be sorry to say how many I have seen in my time, but I well remember the first one which was brought to my notice by a man who had, as usual, put money into it. He could not describe it, but, of course, it differed from all that had hitherto been invented. Finally, when I saw it, it proved to be of the very familiar type of the Beale's exhauster with spring shutters that moved in and out as an inner solid cylinder rotated inside a hollow cylinder. It is of interest to know that Mr. Beale's gas exhauster was invented as a rotary engine, but proved a failure, as all of that stamp have done, and must do, but the inventor, or someone else, converted it into a gas exhauster for which purpose it is very suitable.

The first rotary engine which presented itself to me as really outside the ordinary type, was an uncommonly ingenious machine. The great trouble with rotary engines that have shutters is that there is so very much rubbing friction and so very little piston-generated volume. This the inventor sought to remedy. He placed a cylindrical steam admission valve inside the shaft of the rotor, and admitted steam through this hollow valve. He also revised and varied the cut-off by slightly varying the angular position of this cylindrical valve. It was very ingeniously contrived and was very well made. But the main part of the invention, that which reduced the distance moved by the shutters over the surface of the cylinder, was the elimination of most of the shutter friction, for the cylinder rotated nearly as fast as the inner rotor. The cylinder was carried in roller bearings and went round with the shutter. I do not clearly recollect the whole of the arrangement, but the rotor did not turn on the same center as the cylinder. They were slightly eccentric, and the difference of diameter was made up by shutters which were constantly kept pressed against the periphery of the cylinder. The rotor rolled on the cylinder; that is to say, it drove the cylinder around as if this was an inside gear driven by a pinion, but little smaller than the gear. This rolling contact gave to the rotor and cylinder exactly equal peripheral velocities. The peripheral velocity of the cylinder was, therefore, slightly less than that of the sliding shutters of the rotor, and these moved slowly over the cylinder with a speed that was represented by the ratio of the radius of the rotor body and of the shutter tips when out to their full extent. This movement was slow, perhaps a fourth or a fifth that of the ordinary shutter engine with fixed cylinder. The rotor was in perfect balance, and as the shutters went round with the outer cylinder this was in perfect balance also, though the two rotating bodies did not have the same center of revolution. A small engine appeared to work perfectly. It ran quietly at a very high speed, driving an electric generator in London, and it had no vibration troubles. All its parts were practically lathe finished, the rollers being cut off in lengths, and all was to gage and interchangeable. Where trouble could be seen ahead was in the valve. This internal valve had to stand still, and the rotor rotated upon it. Here was as much surface rubbing as had been gotten rid of in another part of the engine. It was not of serious moment in the small machine, but it bid fair to become serious in machines of larger size, and the point was realized by the inventor, for he considered it to be a suitable machine to form one end of a line of steam engines for which the larger sizes were to be turbines. I never heard what became of this engine, but it was about the best I ever saw, and had points in its small sizes that may have enabled it to live for certain fields of work, as for engines for small launches, or even for steam-driven commercial vehicles.

A neat rotary engine of noticeable excellence was one in which a bilobed rotating piece, similar to the rotor in a Root's blower, rotated eccentrically within a three-lobed casing or cylinder. The two rotating pieces, for the cylinder as well as the rotor proper rotated, were connected by a sort of inside sun and planet gearing which held them rigidly in correct relative positions. This little motor was shown driving a propeller in a glass tank, and it could be instantly and rapidly reversed by the simple movement of a lever. It was exceedingly ingenious and pretty, but it seemed to me that there might be trouble in time with the gearing, the stress upon which was heavy, for the work done on the shaft was the difference of the work done by the two moving parts, and the wheels had to carry a lot of interchange work. I am unable to recollect the valve gear sufficiently to describe it, but the whole engine was very simple and well made. There were, of course, the usual flat ends of the rotor to be kept steam tight against the cylinder.

The next engine of note was of a somewhat different order. A solid rotor cylinder rotated in a cylindrical case of about two or three inches larger radius. A projecting but non-sliding shutter closed the annular space. The problem was to get this piece round the cylinder, and yet to furnish an abutment for the steam to push against. To gain this end a rotary cylinder as large as the rotor was placed in a parallel cylinder and rolled upon the rotor, but it had a longitudinal gullet cut in its surface like the gullet in a Geneva winding stop, and the projecting shutter of the rotor coincided with this gullet at each revolution and thus got round its circle, the rotating valve or chuck cylinder closing the annular passage round the rotor as soon as the shutter or tooth had passed. The two rotors were kept in correct position by a pair of equal gears. What bid fair to make large engines clumsy was that the auxiliary rotor had to be of the same diameter as the rotor which had a rolling contact with it. The engine seen by me moved at a very high velocity and was exceedingly ingenious, but I felt obliged to tell my friend, who was proposing to finance it, that I had seen other rotary engines as good, and I did not know of any rotary engine at that moment that was enjoying a commercial life.

Now this is a fact of great moment to any young engineer who may run up against some form of rotary engine that is going to revolutionize everything. If his pet engine succeeds, let him bear in mind that it is the first one that has done so. What does this mean? It means that there is some practical difficulty that excludes these engines for commercial purposes. Possibly each one of the three engines I have described might find a field in some motor vehicle or boat, for in each case the weaknesses that seemed most apparent to me were not marked in the small sizes, and would only become very serious as dimensions and power increased. It was more or less distressing to know that some man had spent years of ingenuity on these little rotary engines. How do these rotary inventors live? Who finds the early cash to keep the engines afloat, and—if they ever do go to flotation with a secretary and a board of directors, what then becomes of them? They pass into oblivion. One does not see them about. Their users seem all to lie very low, and yet they are full of ingenuity, are often well made, and have gone through a lot of development. But they seem all to be too much tied as to dimensions. They have inherent difficulty for larger sizes, and there seems to be something in the rotary principle which circumvents the most ingenious method of the inventor. The chief trouble, I take it, is the small cylinder volume per unit of piston rubbing surface. Then there is the flat end of the rotor, which has to be kept tight, and so on through other details which perhaps help to explain why so many are called and none are chosen.

* * *

The construction followed in tall office buildings of New York and other cities has an important effect on the insurance rates. The "Caledonian," a new building recently erected in Pine Street, New York, carries an insurance rate of only 50 cents per $1,000. The building has a cast iron frame protected by porous terra-cotta and brick, and is twelve stories high. In contrast to this is a ten-story building in Broad Street, not far from the New York Stock Exchange, which pays twice as much, or $1.00 per $1,000. The addition in rate is because the metal frame is not protected by either terra-cotta or brick.

* Address: 25 Queen Anne's Gate, Westminster, S.W., London, England.

REAMERS.—1.

ERIK OBERG.*

Reamers, in the narrowest sense of the word, include only tools intended for producing a hole that is smooth and true to size. In a wider sense, however, the word is applied to any solid circular tool, with a number of cutting edges, used for enlarging cored or drilled holes, little or no account being taken of whether the resulting hole is strictly true to size or not. With reference to the manner in which the reamers are made, we may distinguish between solid and inserted blade reamers. The latter are usually adjustable for size. With reference to the purpose of reamers, and the manner in which they are used, we distinguish mainly between hand reamers, chucking reamers, shell reamers, and taper reamers. The latter class of reamers is mostly, perhaps, used by hand, the same as the hand reamer, but the hand reamer is considered to mean only a straight reamer, and the taper reamer forms a class by itself. On the boundary between reamers and drills is the grooved chucking reamer, which is used for roughing cored holes, and is fluted with spiral grooves like a twist drill. Center reamers constitute a special class of reamers, which are used for reaming the centers in pieces to be held between the centers in the lathe.

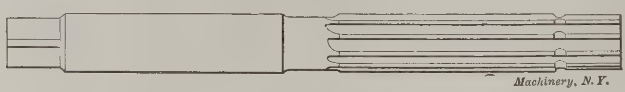


Fig. 1. General Appearance of Hand Reamer, with Guide.

Hand Reamers.

The ordinary hand reamer, provided with guide, is shown in Fig. 1. As seen from the cut, it consists of a cutting portion, a shank, and a square by which it is turned when in use. As is also shown, the end portion of the shank on which the square is formed is turned down below the diameter of the shank proper. The purpose of this is to prevent any burrs that may be raised on the edges of the square by the wrench, by which the reamer is turned, from projecting outside of the diameter of the shank, thus either preventing the reamer from being drawn clear through the hole reamed, or causing scratches in the hole if the reamer be pulled through. Between the cutting portion and the shank there is a short neck, the purpose of which is, primarily, to provide for clearance for the grinding wheel when grinding the cutting edges as well as the shank of the reamer, and also to permit the cutter by which the flutes are cut to clear the shank so as to give a more finished appearance to the tool. The main requirements placed on a hand reamer are that it shall be able to produce a smooth, a straight, and a round hole. The first of these requirements may be obtained in either of three ways: By giving the reamer an odd number of flutes; by fluting the reamer with spiral flutes; or by giving an even number of flutes, but placing these at irregular intervals on the periphery of the reamer. This latter practice is at present the most common one, and is employed by leading manufacturers of reamers. The uneven spacing of the cutting edge is termed "breaking up the flutes," and is the simplest and most effective way of making a reamer which will produce a smooth hole.

For obtaining a straight hole, the reamer should be provided with a guide. This provision is not generally made in reamers manufactured for the market, but is one of great importance in a tool that is expected to produce accurate work. The requirements mentioned are discussed at length in an article on hand reamers in the January, 1906, issue of MACHINERY.

Relief.

It will also be necessary to remark that giving too much or too little relief to a reamer will tend to produce unsatisfactory results. Too much relief invariably causes a reamer to chatter. Too small relief, again, will wear the reamer more, as the shavings get in between the cutting edges and the work to be reamed and slowly grind away the land; besides, there is a tendency to bind the reamer in the hole, with the consequent results of injuring the hole as well as the reamer, and causing the expenditure of more exertion in performing the reaming operation.

In this connection it might be mentioned that the flat relief, although mostly used, is not the most desirable, nor the ideal one, because the cutting edge is not properly supported. The best results are obtained by a relief as shown in Fig. 2. The difference between this relief and the flat is very obvious from the cut, where the latter relief has been shown in dotted lines. This special relief, usually termed the eccentric relief, is used only by two prominent tool manufacturers, but it is to be strongly recommended, because it adds greatly to the reamer's capability of producing a smooth hole. The relief is produced by placing the reamer in a grinding machine, as usual, but not on centers in line with the spindle, but on auxiliary centers, provided with adjustment sideways, so as to enable them to be set at different positions for different relief wanted on different sizes and kinds of reamers. The reamer is thus held eccentrically. A rocking motion is then imparted to the spindles holding the auxiliary centers, and in this manner the grinding wheel, traveling forth and back along the reamer, will produce an eccentric relief.

This eccentric relief, however, is not in favor with all users of reamers. The eccentrically relieved reamer is purely a finishing reamer, and cannot with advantage be used to remove any considerable amount of metal, because it has practically a negative rake. When hand reamers are used merely for the purpose of removing stock, or in other words, simply for enlarging holes, the flat relief will undoubtedly prove to be superior to the eccentric. The primary use of straight hand reamers, however, is for producing holes true to size and smoothly finished, removing meanwhile but a small amount of stock. For this purpose nothing excels the eccentric relief. That there is a distinct difference between the relief required, according to the use to be made of the reamer, is best proved by the fact that, while some manufacturers of tools always relieve their reamers eccentrically, intending them to be used as finishing reamers, some of their customers, after receiving an order, place the reamers in a grinding machine and replace the eccentric relief with a flat one, because they find this relief better for their purposes, *viz.*, simply enlarging holes, irrespective of the highest requirements of accuracy and smoothness.

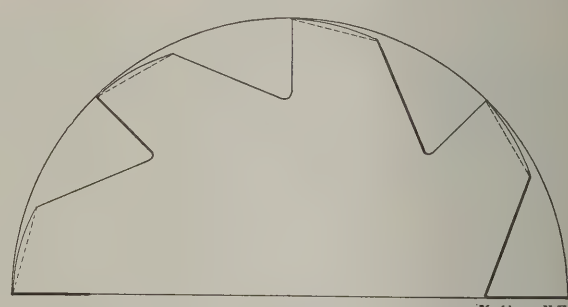


Fig. 2. Comparison of Relief of Reamers.

Reamers with Helical Flutes.

Although the advantages of helical, or, as it is commonly called, spiral cutting edges are somewhat doubtful for straight reamers for ordinary use, they are recommended for such work where the hole reamed is pierced crosswise by openings. A [illegible]nded reamer should have left-hand spiral flutes, in o[illegible] prevent the tool from drawing into the work. The angle of spiral should be such that the cutting edges will make an angle of 15 degrees with a plane passed through the axis of the reamer. The number of flutes may be the same as if the reamer were provided with straight cutting edges, and the same kind of fluting cutters are employed.

Threaded-end Hand Reamers.

Hand reamers are sometimes provided with a thread at the extreme point in order to give them a uniform feed when performing the reaming operation. The diameter on the top of this thread at the point of the reamer is considerably smaller than the reamer itself, and the thread tapers upward until it reaches a dimension of from 0.003 to 0.008 inch, according to

* Address: 692 Hancock St., Brooklyn, N. Y.

size, below the size of the reamer; at this point the thread stops, and a short neck, about 1/16 inch wide, separates the threaded portion from the actual reamer, which is provided with a short taper from 3/16 to 7/16 inch long, according to size, up to where the standard diameter is reached. In fact, the reamer has the appearance of the regular reamer in Fig. 1, excepting that the guide is threaded and tapered.

The length of the threaded portion, and the number of threads per inch with which to provide the point, are given below:

Size of Reamer.	Length of Threaded Portion.	No. of Threads per inch.
From 1/8 to 5/16 inch............	3/8	32
From 11/32 to 1/2 inch............	7/16	28
From 17/32 to 3/4 inch............	1/2	24
From 25/32 upward	9/16	18

The kind of thread employed is the sharp V-thread, as this thread gets a better grip on the metal, and thus feeds the reamer in a more certain manner.

The diameter measured over the top of the thread at the end of the point of the reamer should be as follows:

Size of Reamer.	Diameter of Thread at Point of Reamer.
From ⅛ to ½ inch.........	Standard size—0.006 inch
From 17/32 to 1 inch.......	Standard size—0.008 inch
From 1 1/32 to 1½ inch....	Standard size—0.010 inch
From 17/32 to 2 inches	Standard size—0.012 inch
From 2 1/32 to 2½ inches...	Standard size—0.015 inch
From 2 17/32 to 3 inches...	Standard size—0.020 inch

Number of Flutes.

The following table gives the number of flutes with which hand reamers should be provided. It will be noticed that even the smallest sizes are provided with six flutes. It is not considered good practice to make hand reamers with a smaller number of flutes, if good results are expected from the use of the tool.

TABLE I. NUMBER OF FLUTES IN HAND REAMERS.

Size of Reamer.	Number of Flutes.	Size of Reamer.	Number of Flutes.	Size of Reamer.	Number of Flutes.
⅛	6	⅞	8	1¾	10
¼	6	1	8	2	12
⅜	6	1⅛	8	2¼	12
½	6	1¼	10	2½	14
⅝	8	1⅜	10	2¾	14
¾	8	1½	10	3	16

From the table above it will be seen that the pitch of the teeth, or the distance from cutting edge to cutting edge around the circumference of the reamer increases from about ⅛ inch for a ¼-inch reamer, to about 9/16 for a 3-inch reamer. The pitch of the cutting edges for a 1-inch reamer is about ⅜ inch, and for a 2-inch reamer slightly more than ½ inch.

Fluting Cutters for Reamers.

Often the same kind of fluting cutters as are used for hand taps are employed for reamers also. The reamer, however, does not remove the same amount of metal as does the tap, and consequently there is no need for the same amount of chip room. The radius in the bottom of the flute is made smaller, because the flute, being made shallower, does not take away so much of the strength of the reamer, and consequently the reinforcement in form of a liberal round in the bottom of the flute is not necessary. Besides, the flutes on very small reamers are so shallow that a comparatively large radius on the fluting cutter would give too great a negative front rake to the teeth.

Figs. 3 and 4 give the usual forms of reamer fluting cutters. Fig. 3 shows a cutter of the same kind as used for taps, but with a smaller radius *D*. This class of cutter is used for smaller size reamers, say, up to 1¾ inch diameter inclusive, while the cutter, Fig. 4, is used for larger sizes. The included angle between the cutting faces of the cutter is 85 degrees in both cases, the same as for tap fluting cutters, but while the cutter, Fig. 3, has one face making 55 and the other 30 degrees with a line perpendicular to the axis of the cutter, in the cutter, Fig. 4, these angles are 70 and 15 degrees, respectively.

In Table II are given the dimensions commonly employed for these cutters, and the corresponding sizes of reamers for which they are used.

Setting the Cutter for Fluting.

When setting the cutter for fluting hand reamers, it should be set so that the tooth gets a slight negative rake, that is, the cutter should be set "ahead" of the center as shown in

TABLE II. FLUTING CUTTERS FOR REAMERS.

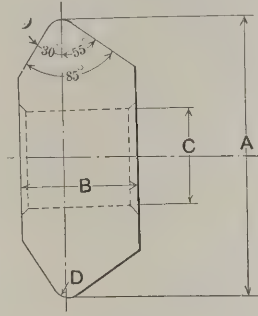


Fig. 3.

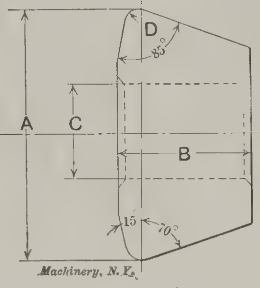


Fig. 4.

Diameter of Reamer.	Diameter of Fluting Cutter.	Thickness of Fluting Cutter.	Diameter of Hole in Cutter.	Radius between Cutting Faces of Cutter.
	A	B	C	D
⅛	1¾	3/16	¾	sharp corner, no radius.
3/16	1¾	3/16	¾	sharp corner, no radius.
¼	1¾	3/16	¾	1/64
⅜	2	¼	¾	1/64
½	2	5/16	¾	1/32
⅝	2	⅜	¾	1/32
¾	2	7/16	¾	3/64
1	2¼	½	1	3/64
1¼	2¼	9/16	1	1/16
1½	2¼	⅝	1	1/16
1¾	2¼	⅝	1	5/64
2	2½	¾	1	5/64
2¼	2½	¾	1	5/64
2½	2½	⅞	1	3/16
2¾	2½	⅞	1	3/16
3	2½	1	1	3/16

Fig. 5. The amount to set the cutter ahead should be so selected that the angle included between the front face of the tooth and the tangent to the circumference of the reamer at the point representing the cutting edge is 95 degrees (see Fig. 5). A reamer will cut smoother if the cutting edge of the tooth has a negative rake than it will if the front face of the tooth is radial.

In Table III the dimension *a*, Fig. 5, or the amount to set the fluting cutter ahead of the radial line, is given. The figures in Table III give the angle *A B C* approximately 95 degrees, as mentioned. There may be objections raised to setting the fluting cutter as much as ⅛ inch ahead of the radial line for 3-inch reamers, but inasmuch as the angle of negative rake remains the same as for smaller sizes, there is no good reason why this amount should be made any smaller than given in the table.

TABLE III. TABLE FOR SETTING FLUTING CUTTERS FOR REAMERS.

Size of Reamer.	*a* (See Fig. 5) inches.	Size of Reamer.	*a* (See Fig. 5) inches.	Size of Reamer.	*a* (See Fig. 5) inches.
¼	0.011	⅞	0.038	2	0.087
⅜	0.016	1	0.044	2¼	0.098
½	0.022	1¼	0.055	2½	0.109
⅝	0.027	1½	0 066	2¾	0.120
¾	0.033	1¾	0.076	3	0.131

The depth of the flute should be such that the width of the land of the tooth is about one-fifth of the average distance from the cutting edge of one tooth to the cutting edge of another. Should it not be as deep, there will not be sufficient space in the grooves to hold the shavings. Should it be deeper, the strength of the tooth will be impaired, and the cutting edge is likely to spring out when taking the cut, pro-

ducing a hole larger than the reamer. The difficulties encountered in milling the flutes on unequal distances, or breaking up the flutes, as it is commonly termed in the shop, are that, if all the grooves are milled to the same depth, the remaining land evidently will be wider in the case where the distance from cutting edge to cutting edge is larger than it will be in the case where this distance is smaller. To overcome this it would, of course, be possible to mill the flutes deeper between the cutting edges which are farther apart to insure that the width of the land would be equal in all cases. That this is impracticable when fluting reamers in large quantities is easily apprehended, as it would necessitate raising or lowering the milling machine table for each flute being cut. The width of the land will, therefore, vary somewhat when the flutes are "broken up," but of uniform depth. For a more thorough discussion of this matter see MACHINERY, October, 1899, "Irregularly Spaced Reamers," and February, 1907, "New Method of Milling the Flutes of Reamers."

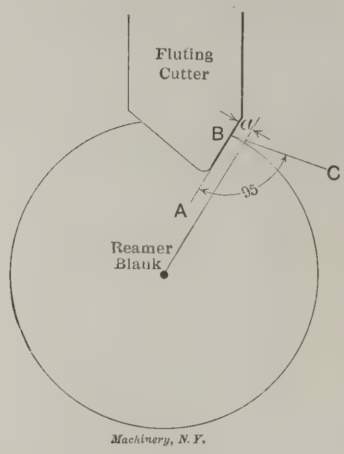


Fig. 5. Setting the Cutter for Fluting.

Precautions in Hardening Reamers.

If the reamers to be hardened are larger than ¾ inch in diameter they should be held over the fire immediately after being taken from the hardening bath, in order to as much as possible remove the strains caused by the hardening process. Another method is to remove the reamer from the water bath as soon as it stops "singing" and plunge it immediately into an oil bath, allowing the tool to stay in the oil until its temperature has been reduced to that of the oil. The temper should be drawn to 370 degrees F. If reamers spring in hardening they are heated slightly, and pressure applied to the convex side, the reamer being held between centers in the same manner as in a lathe. This same method is applied to long taps and to counterbores and drills.

* * *

A paragraph in the *Electrical Review*, June 8, 1907, gives an idea of the refinements necessary in experimenting with some of the new problems brought out by the discovery of radium and other radio-active substances. A paper recently read before a German technical society was said to be interesting on account of the "emphasis which it put upon the necessity of avoiding every possible source of error in the study of this new and striking branch of physical science. With the material sealed within a glass vessel, there was an apparent change in weight easily measured in a balance. This seemed at first good evidence of a loss of weight, as the tube became lighter; but the difference in weight was finally found to be caused by the changes in temperature of the tube and its contents, due to the chemical changes going on within it. This increase in temperature, by causing a slight increase in the volume of the tube, decreased its specific gravity, and thus gave rise to the apparent change in weight. When the tube had come to a stable condition and reached its original temperature, the weight was found to be identically what it had been when the tube was sealed up. Thus, it will be seen that all apparent effects may not be real, no matter how carefully the observations were made, and whenever they are in disagreement with our fundamental ideas of physics and chemistry, they should be scrutinized closely and put to every possible test. The new phenomena are puzzling enough, and are changing our ideas of matter rapidly. There is therefore all the more need to be careful."

* * *

In the hot hereafter, prick-punch fitters have a special place reserved.

AUTOMATIC NEEDLE-MAKING MACHINERY.

The accompanying photographs, Figs. 1 and 2, and line drawings, Figs. 3 and 4, show an interesting machine built by the Langelier Mfg. Co., Providence, R. I., for finishing sewing machine needles after they have been formed to shape on a rotary swaging machine of special design adapted to this particular class of product. The machine takes the swaged needle, which is fed into a magazine, cuts it to length, mills the grooves on the sides, perforates the eye for the thread, and rolls the number and name of the maker, if required, upon the shank. The four functions of the machine are performed automatically, and because of this combination, if nothing more is conceded, it constitutes an interesting example of machine design which does what a number of machines are ordinarily required to do.

In this connection, it is interesting to note that needle manufacturing is one of the oldest arts, and that its machinery, though primitive, was ingenious and interesting, being among the earliest examples of special machinery used in the metal-working arts. Needles were made from steel wire, being cut from the coil without straightening, this having to be done individually for each pair of needles, it being the practice to make them two together, with the eyes in the center. For many years the needle-makers of Redditch, England, held a practical monopoly of the business of making hand sewing needles, but in after years German needle-makers sprung up who became active competitors, many workmen from England being imported to Germany to teach the art. The machinery of these older needle-makers, of course, was of a very primitive design, and it was all of the unit type, each machine being designed for one operation, and each required the superintendence of a workman for its operation, and the same condition largely exists still in European needle manufacture. In this country the manufacture of needles and similar products is largely done by special machinery, developed by the manufacturers or built to order by makers of special machinery. In Europe, a manufacturer who intends to go into this line of business expects to buy the machinery for it in the open market. The difference comes about, of course, from the fact that American manufacturers generally act upon the principle of reducing the labor cost to a minimum, while the European makers do not strive so much to reduce labor cost as to have machinery that is of a so-called standard type and of simple

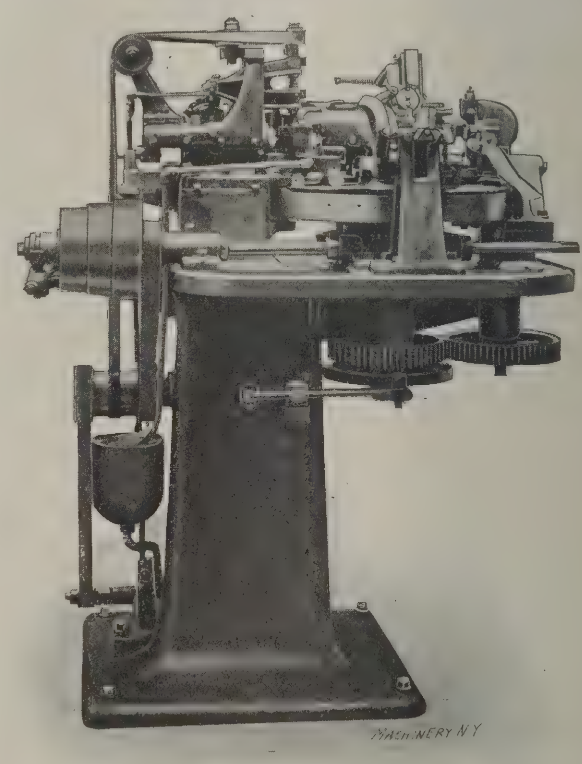


Fig. 1. Langelier Needle-making Machine, Magazine Side.

and cheap construction. The machine illustrated may, therefore, be regarded as a development of the American idea of making a machine that combines within itself a number of functions, which are automatically performed from start to finish without the interposition of manual labor.

The line drawing, Fig. 3, shows a plan view of the machine, which is another adaptation of the turret principle in machine design. The needles are thrown into a magazine *F*, where they drop into the longitudinal slots of a revolving truncated cone-shaped receiver and undergo the first operation at *A*, which is cutting to length. Each needle in turn then drops from the receiver into the slot of a horizontal reciprocating trough that in itself contains the necessary mechanism for accurately loading each of the chucks as they arrive in position opposite the trough. At no time are the needles out of control of the mechanism. The turret then indexes the needle one-quarter turn and brings it opposite the grooving machine *B*, which consists of two vertical spindles carrying angular milling cutters. These work through narrow slots in a suitable grooved receiver, which holds the needle firmly in position while the cutters work on the opposite sides of the needle and produce the grooves required for the protection of the

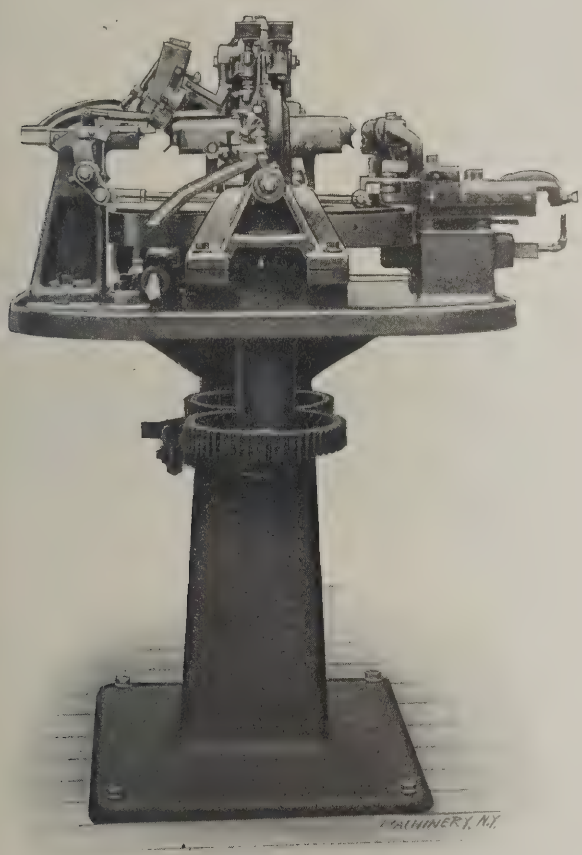


Fig. 2. Needle-making Machine, showing Numbering and Lettering Head in Front.

thread when penetrating the cloth. One side of a needle has a longer groove than the other, and this difference in length is automatically effected by the mechanism. When the grooving has been completed, the turret again indexes to the third position, *C*, where a punch automatically perforates the eye. The distance of the eye from the point is regulated by the screw *E*. The punches vary, of course, in thickness and width, according to the size of the needle and the size of the thread to be used. One size punch in common use, for example, is 0.032×0.014 inch. From this position, the turret again shifts the needle to the fourth position, *D*, where the number of the needle is automatically imprinted upon the shank, thus completing the functions of this machine. It should not be concluded, however, that the needle after leaving the machine is practically completed. Far from it. It still has to be pointed, the eye has to be polished out so as to let the thread slip easily, and the whole needle has to be polished, besides going through a number of minor operations, but the four operations performed by this machine are, with the exception of the pointing, the principal ones that have to be done after it is swaged to form.

An interesting feature of design of this machine is the cam-plate *G*, Fig. 4, by which the functions of the turret operating tools are controlled. This cam carries two races on its upper side and one on the lower side. The compound race on the

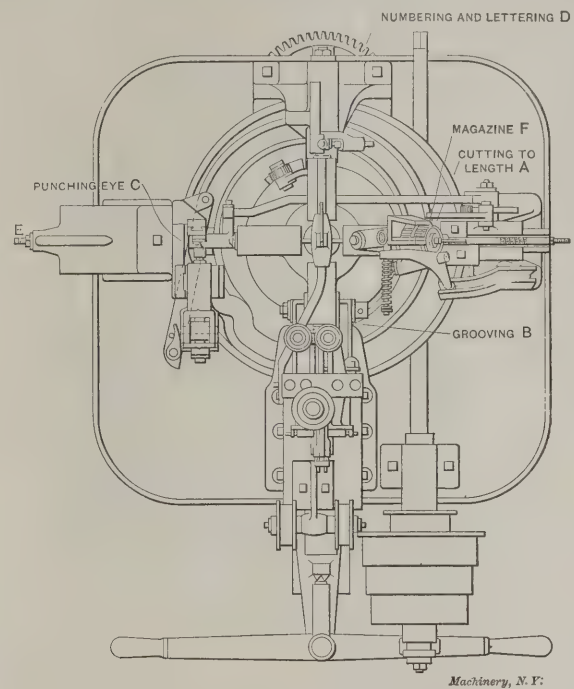


Fig. 3. Plan of Needle-making Machine.

upper side effects among others the pretty operation of controlling the feed-to-depth motion of the milling cutters and the longitudinal feed as well. This came is in continuous motion, being driven by the worm-wheel *H*. The turret is actuated by a segment gear, attached to the under side of the cam-plate, which engages the pinion *L* and actuates the turret through gears *M* and *N*.

The half-tone, Fig. 5, shows a view looking toward the faces of the swaging heads of the three-head rotary swaging machine which makes the needle blanks ready for the machine just described, and Fig. 8 shows the reel, wire straightening rolls, and a portion of the swaging machine, taken from the

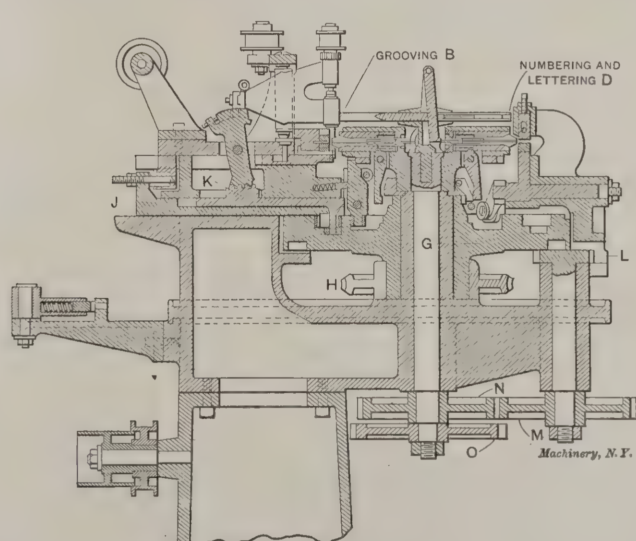


Fig. 4. Section through Needle-making Machine.

same side as shown in Fig. 5. Figs. 6 and 7 show the successive steps of the operations of swaging, grooving and piercing of the needle. The automatic swaging machine takes the wire from the coil, straightens it, cuts off the blank from the wire by a milling operation and swages it to shape in three operations, the blanks being fed successively, by a four-chuck turret having a horizontal axis, to the three heads of

the machine. The design of the machine is positive. The principle of keeping the blank always within the control of the machine is carried out the same as in the grooving and eyeing machine, the blank being continually within the grasp of the chucks until the three swaging operations are completed.

The swaging heads are made on the same principle as that employed in the regular Langelier machine, which was shown,

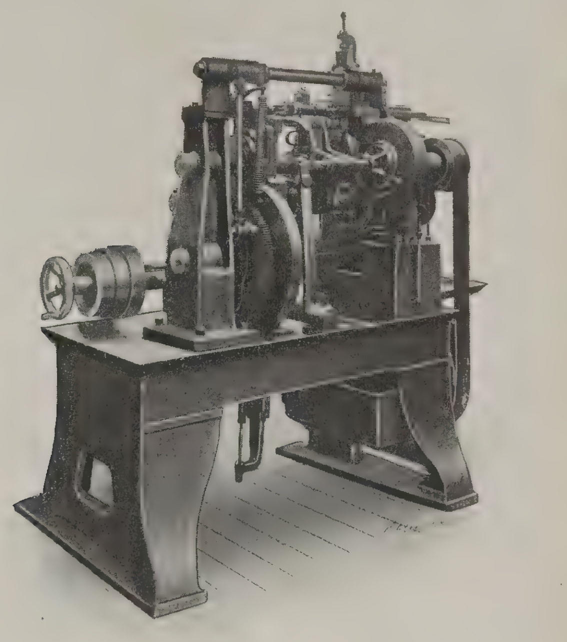


Fig. 5. Machine for Making Needle Blanks.

with interesting examples of work produced, in the May, 1903, issue of MACHINERY. Briefly, the construction consists of an outside stationary head of heavy construction in which there is an axial hole for the rotating head. The rotating head carries two dies in a radial slot. These dies tend to fly outward under the influence of the centrifugal force when rapidly rotating. Around the inner circumference of the hole in

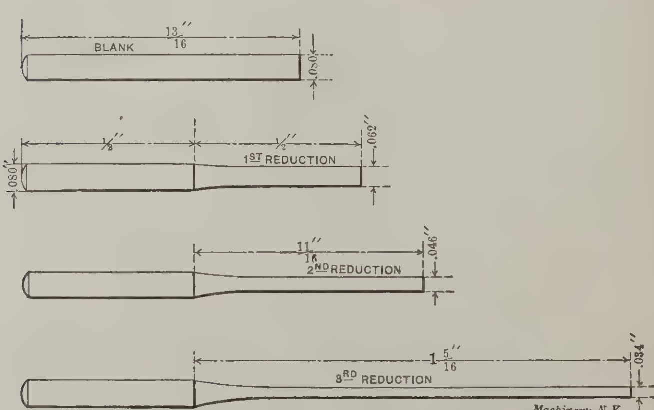


Fig. 6. Successive Steps in Swaging.

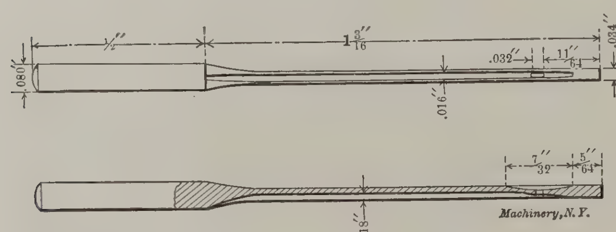


Fig. 7. Operations of Grooving and Piercing.

the stationary head there are located eight steel rolls with which the ends of the rotating dies come in contact as they turn, thus throwing them to the center. During one rotation of the revolving head the dies are forced together eight times, hence the wire receives eight times as many blows per minute as the number of rotations. The result of thousands of blows delivered in so short a time is a very rapid action in reducing wire stock to any required form.

NOTES ON CAM DESIGN AND CAM CUTTING.*

JAMES L. DINNANY.†

James L. Dinnany.‡

It is strange that the processes and methods of cam cutting have not been improved more rapidly than they have. Twenty-five years ago, in the first shop I worked in, cams and gears were on about an equal footing; that is to say, most of both were cast to as nearly the proper shape as possible, after which the working surfaces or teeth were smoothed up with a file, and then the holes and hubs were finished in the usual manner. Some cams of both plate and barrel forms were cut, with suitable attachments, in the same machine the gears were cut in. This was an old hand indexing machine, with an automatic feed composed of a weight hung on the pilot wheel. Since that time gear cutting machinery has been wonderfully developed. All sorts of styles and arrangements are on the market, meeting every demand, from that for a general purpose machine to highly specialized forms. When it comes to cam cutting machinery, however, while machinery builders have special tools for their own work, so far as the writer is aware, there is no tool regularly on the market for cutting

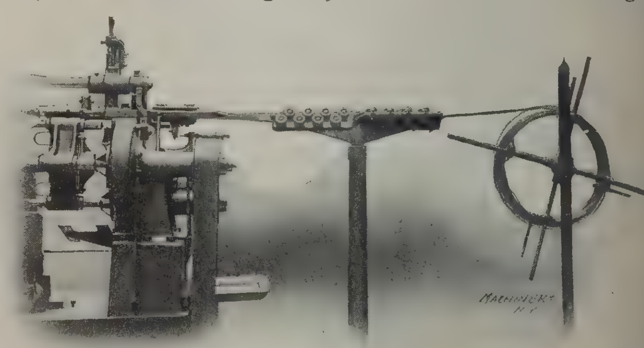


Fig. 8. Reel and Wire Straightening Rolls.

cams. The cam has thus fallen away behind the gear in the process of development. Machine designers and machine users are liable to be a little suspicious of cams, anyway. Considerable trouble is often taken to avoid the necessity for using them. This is due, however, as much to faulty design and faulty construction as to any inherent objections to this form of mechanical movement. The writer proposes to call attention to some of the points to be considered in designing and producing satisfactory cams, with the thought of thereby doing something to justify a more extensive use of them.

Faults in the Design of Cams.

We have all seen cams that were the cause of a good deal of profanity, in which the trouble could be traced to the designer or machinist, who laid out the curves on what might be termed "schedule time"; that is to say, he simply made sure of his starting and stopping points, neglecting all intermediate points so long as the movement got there and got back on time. This, he thought, would be all that was necessary, not taking into account the shock and jar caused by the sudden starting and stopping of heavy slides, levers, etc., at even moderate speeds. The temptation to do this is always strong,

* For additional information regarding cam design and cam cutting, see the following articles, previously published in MACHINERY: The Drafting of Cams, March and April, 1896; Cam Cutting, November, 1898; Making Master Cams, July, 1904; On the Shape of Rolls for Cylinder Cams, December, 1904; Cam Curves, April, 1907; Effect of Changing Location of Cam Roller, July, 1907.

† Address: 46 Lippitt St., Providence, R. I.

‡ James L. Dinnany was born at Taunton, Mass., in 1864. The first four years of his mechanical experience were spent in the Mason Machine Works, Taunton, Mass., following which he worked for the Fall River Machine Co., Fall River, Mass.; American Ordnance Co., Bridgeport, Conn.; Driggs-Seabury Gun Co., Derby, Conn.; Corliss Steam Engine Co., Providence, R. I.; Brown & Sharpe Mfg. Co., Providence, R. I., and other concerns. At present he is with Fulford & Hobart, Providence, R. I. Mr. Dinnany's specialty is automatic machinery.

especially in the case of barrel cams, where it is so much easier to use the milling machine (gearing it up for a spiral to meet the schedule requirements) than it would be to lay out and form a curve with a gradual starting of the motion and a gradual stopping. There is nothing worse for the life of a machine than to have it operated by cams cut by this "schedule" method. Another point to consider is that of taking advantage of all the time there is for any given movement. The period or periods of rest should be cut down to the last degree, so as to have the angularity of the rise as small as possible. Careful work at the drawing-board will make a big difference with the satisfactory action of cams in these two respects. Still another bad practice, which has perhaps tended to throw the use of cams into disfavor, is that of making them in two or more parts, with the idea of having the working surfaces adjustable. After they have been wedged out, or shimmed up, or ground off a few times, a more proper name for them would be "bumpers" rather than "cams." Except in rare cases, there is no more use or excuse for adjustable cams than for adjustable gears, as there are other and better means of making adjustments when these are necessary. Cams are not very expensive as compared with gears, and they can be duplicated with greater accuracy than most machine parts. Especially is this the case if roughing and finishing mills are used in forming them, as the finishing mill will retain its cutting edge and size for a great number of cams if it runs true with the spindle in the first place.

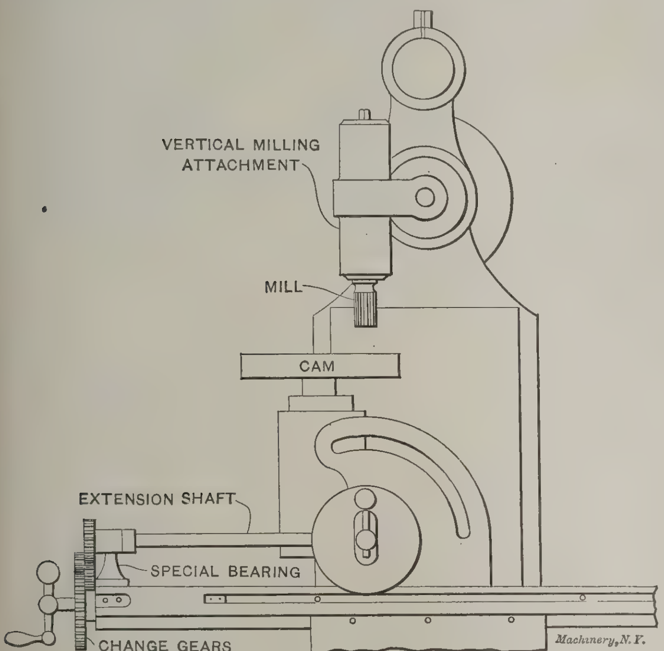


Fig. 1. Cutting a Face Cam of Uniform Rate of Throw.

Cam Rolls and Roll Studs.

A few words might be said with relation to the design and construction of cam rolls and the studs for them, since the successful working of a cam depends to a considerable degree on this matter. The design of the roll and its stud should be such that the work it has to do, the speed at which it runs, and the bearing area on the stud, should be the factors determining its size, rather than the simple fact that there is a milling cutter in the tool-room of a certain diameter. It is equally important that the roll and stud should be ground all over after hardening. The end of the roll should also be cut back for 1/64th of an inch or so on the sides for some distance from the outside diameter, so as to avoid undue friction against the collar of the stud, or the part it is fast in. On account of the warping that takes place in hardening, rolls that are not ground inside and out have a habit of stopping frequently under load, until in time flat spots are worn on the face; then the working surface of the cam will begin to wear or rough up. Roll studs that are the slightest degree out of parallel to the working surface of the cam will also cause some trouble, but no amount of grinding will help this case. The same trouble occurs on barrel cams if the milling cutter is set above or below the center of the cam when cutting it. The roll will then bear at one end only at the most important time, when the throw takes place. A conical roll is the proper thing for this style of cam. There is a lot of end pressure to a roll of this type, however, which must be taken care of by thrust collars on the stud; or, better still, a ball race may be scored in the collar and the large end of the roll, so as to provide for a ball thrust bearing. This end pressure will reduce the side pressure on the stud to quite an extent, nevertheless, so the latter may be made slightly shorter or smaller in diameter than when a parallel roll is used.

Cutting Cams of Uniform Lead in the Miller.

When it comes to the cutting of cams, the shop man naturally turns to the milling machine. Many manufacturers of milling machines make attachments which may be used for cutting cams with formers. None that the writer has ever seen, however, is provided with anything except hand feed. Another, and the greatest, objection to them is that if there is much work to be done, one of the most expensive machines in the shop is tied up, and there are few shops that have a surplus of this brand of machine tool. For an occasional or an experimental job, however, there is nothing better than the milling machine. As has been before remarked, curves with easy starting and stopping movements cannot be cut without formers on it, or on any other machine for that matter; but cams which require a constant rise, such as the feed cams of some machines, may be cut on it without the use of formers. With barrel cams the method is obvious, it only being necessary to gear the spiral head with the lead screw to get the required lead, and then cut a groove of this pitch in the body with an end mill of the same diameter as the roll.

For cutting plate cams for the same kind of motion, the arrangement shown in Fig. 1 may be used, if the machine happens to have a vertical spindle milling attachment and a spiral head. All that it is necessary to provide in addition is the extension shaft shown, and the special bearing or bracket for supporting it. These parts are used to bring the spiral head to the center of the table. The shaft is bored out at one end to fit the stud of the spiral head (called the worm-gear stud in the tables) the other is turned and keyed to fit the change gears. The cams may be held in the regular chuck, or on a face-plate fitted to the head. Small ones may be held in an arbor fitted to the spindle, with large collars to hold them firmly, clamped with a nut and washer, or by an expansion bushing in the case of large holes. If they have key-ways in them and more than one or two are to be made, it will be well to fit a key in the arbor to help locate them. It is necessary to set the mill central with the spiral head

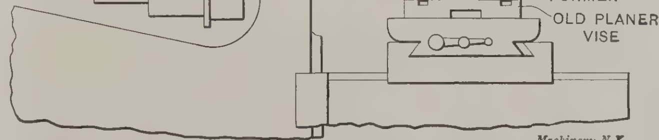


Fig. 2. Inexpensive Fixture for Milling Plate Cams to Match a Former.

to obtain correct results, as the spiral will vary if this is not done. Advantage may sometimes be taken of this when, with the regular change gears, there is no spiral of the exact pitch required, in which case the desired rise can be obtained by setting the head off center. This, however, will not give a uniform spiral, as the pitch will keep increasing as it leaves the center of the cam. As cam drawings are generally laid out or divided in degrees, it will be found convenient to divide the cam blank by the same method, while held in the spiral head. To do this, we may revolve the index crank through two holes in the 18 circle or three holes in the 27

circle, as many times as are necessary, each of these divisions giving exactly one degree.

A Milling Machine Attachment for Cutting Cams with a Former.

Not long ago I was working in a shop with a rather limited equipment, when an order came in for a lot of eight machines, which required seven cams each, most of which were of the plate type. As this class of work was new to the shop, we were without any facilities for this part of the job; as usual, it was decided to do the work on the milling machine. The methods used are shown in Figs. 2 and 3.

An old planer vise was scraped up and refitted so as to have the movable jaw a nice sliding fit—the screw having been removed, of course. To this jaw was fitted and bolted the spiral head of the miller, in such a way that its spindle could be placed either at right angles or parallel to the cutter, as the case required for barrel or plate cams. An arbor was made, long enough to pass through the head, carrying the former on the back end and the cam blank on the front end. A nut threaded onto the back end held the former against the end of the spindle, so there was no danger of the arbors rattling loose, no matter how badly the work and tool chattered.

For plate cams, as shown in Fig. 2, the former was made the opposite hand to that of the cam required. The overhanging arm had a center line marked on it as shown, which was matched with one on the frame so as to locate the arbor support central with the spindle. In the place of the arbor supporting center there was fitted a stud with a roller of the same diameter as the cutter. The arm was held securely by the regular milling machine braces, which are not shown in the cut. The method of operation is obvious. The spiral head with its attached work and former was revolved, slowly, by hand. The action of the roll, held by the overhanging arm in the groove of the former, causes the head and work to slide back and forth on the ways of the planer vise, giving the proper movement between the work and the cutter to produce the desired contour of cam. The table is locked on the saddle.

For barrel cams, the attachment was rearranged as shown in Fig. 3. The former roller was held firmly in a bracket bolted to the table of the machine. As the roller is on the

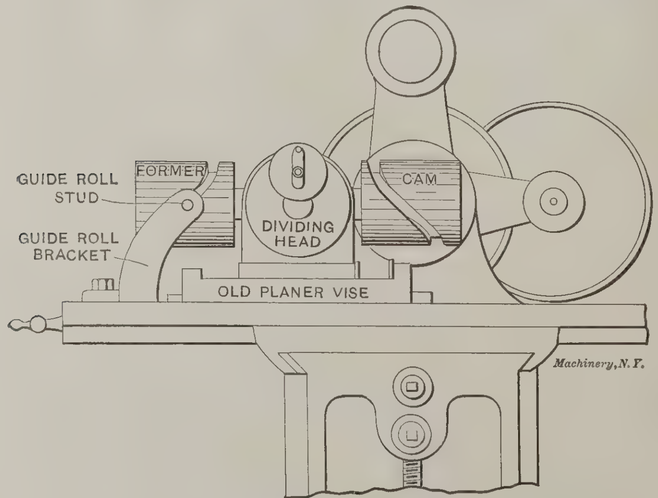


Fig. 3. Cutting a Cylindrical Cam with the Rig shown in Fig. 2.

opposite side of the milling cutter, the former and work are set 180 degrees apart on the work arbor, otherwise they are alike. The head is relocated on the movable vise jaw to bring the axis of its spindle at right angles to the axis of the cutter, as shown. The reader will be able to make out the other details from the cut.

Both of these rigs cut good cams, considering that the first cost of the whole outfit was very little. As the formers were made accurately to drawing, the cams gave good satisfaction at fairly high speeds, but the device had the disadvantage of tieing up a machine which had plenty of work waiting for it; besides it was a tedious job to feed the index crank by hand all day long, especially when working on steel cams. For these reasons, when a duplicate order came in, a few weeks later, it was considered best to try the plan of cutting the plate cams on an old lathe, thus giving us the advantage of an automatic feed, and relieving the miller of some of its work as well.

A Face Cam Cutting Attachment for the Lathe.

A lathe cam cutting attachment is shown in Fig. 4. While not new in principle, it differs somewhat from the other makeshifts described, and works better than most devices of the kind I have seen. The tool slide was removed from the machine and replaced with the bracket casting shown. This was fitted and gibbed to the tool-rest slide, and had its spindle bored and sides faced with a boring bar on the lathe centers. To the bracket was then fitted the cam face-plate and spindle, cast in one piece and finished all over, with the back or small

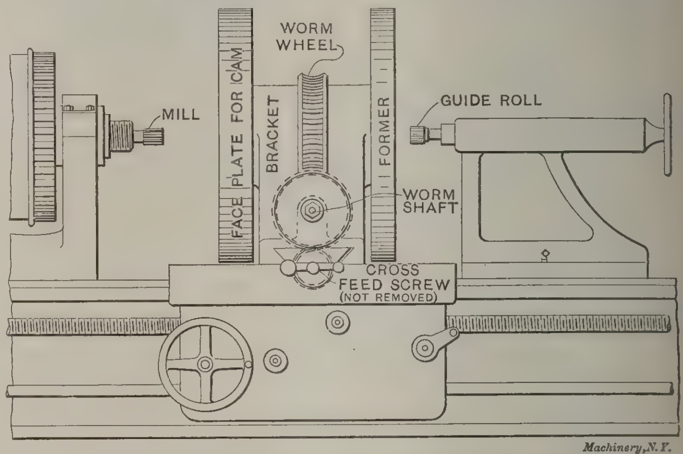


Fig. 4. Attachment with Power Feed for Cutting Face Cams.

end threaded to fit the former. Keyed to this spindle is a worm-gear of cast iron. In our case this worm gear had 82 teeth. Meshing with this gear is a worm having 9/16 inch hole, and a key and keyway, a sliding fit on the worm shaft. Bearings are provided for the worm shaft at front and back. The front support for the worm shaft was cast onto the bracket, and finished with it to fit the tool-rest slide, after which it was sawed off and fastened at the front of the carriage by the gib screw, as shown. This is the same practice as is commonly followed in making the clamp for the threading stop on the cross slide. To the outer end of the worm shaft is keyed a gear, meshing with another fitted and keyed to the front end of the cross feed screw next to the handle. The quill was cut off to make room for it. The cross feed nut was removed entirely, of course.

It will be seen that this arrangement, while having the general features of that shown in Fig. 2, gave us the advantage of making use of a less costly and less over-worked machine, and allowed us to use a power feed as well, since the gearing provided for connection with the power cross feed in the apron. This gave a feed fine enough for small cams, but on large ones it was necessary to run the feed belt from the feed shaft cone to the hub of the large intermediate gear of the screw cutting train, this being in mesh with the spindle gear. The lead screw was removed so as not to interfere with the belt. With regular changes this gave a wide range of feeds.

The cams and formers were held to their respective face-plates by bolts. All the formers were of the positive follower type having a groove for the roller to follow in. They require no weight or other means to hold them to their work.

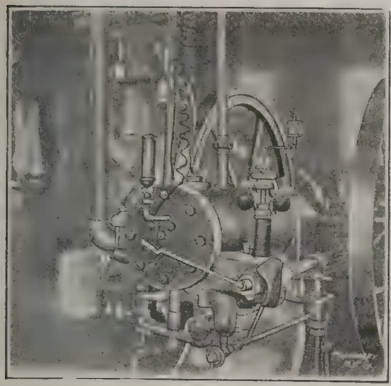
* * *

At the recent meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers, E. W. Roberts performed some startling experiments with gasoline, lighting the vapor as it arose from an ordinary can and pouring gasoline into it as it burned, showing that it could not flash back into the can as that was full of gasoline vapor, forming rapidly enough to expel the air, and burning only after it issued into the atmosphere. The only danger of explosion is when a very small quantity of gasoline evaporates in a vessel, forming not enough vapor to expel the air, but sufficient to make with it an explosive mixture.—*Power*.

ITEMS OF MECHANICAL INTEREST.

STEAM WHISTLE OPERATED BY GAS.

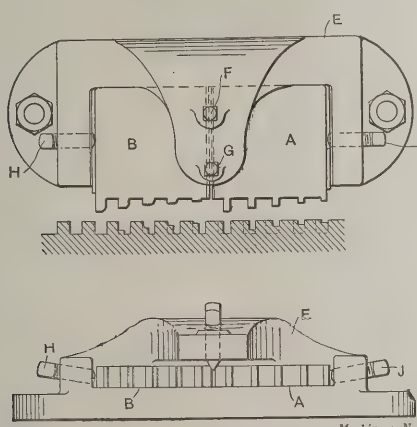
Not long ago I was in a small shop that got its power from a gas engine. It was just 12 o'clock, and I was surprised to hear two or three loud blasts from a steam whistle. I inquired if they kept a tank pumped with air at a high pressure, and was thereupon shown the following, which I managed to get a photograph of. As shown, a quarter-inch pipe leads from a hole in the cylinder head direct to a steam whistle with a small finger valve for operating. This makes me think how foolish so many gasoline yacht owners are, to go to the expense of hand whistles, etc., when with a "direct connected" they could get a blast of hot gas at between 200 and 300 pounds pressure. W. L. McL.



Steam Whistle Operated by Gas.

TOOL FOR CUTTING SQUARE SCREW THREADS.

In the cut below, taken from the *Mechanical Engineer*, is shown a tool of the chaser type for cutting square screw threads. This tool has been recently patented by Messrs. C. & G. B. Taylor, Bartholomew St., Birmingham. Ordinarily, square screw-thread tools, even when they have been used very little, are found to have worn to such an extent that the resulting groove is not as wide as required. It is obvious that it is impossible to regrind these tools after the sides of the cutting teeth have worn down below the required width. With the hope of overcoming this defect, the tool shown in the cut has been designed. As seen, the tool consists of two halves, *A* and *B*, each being provided with teeth which gradually cut the groove to the required depth. The required width is obtained by adjusting the relative position of the two tools *A* and *B*, so that the tool *B* widens the groove already cut by *A*. These two tools or chasers are held in a tool-holder *E*, and the adjustment is effected by means of two screws *F* and *G* having conical ends, which are forced in between the tools *A* and *B*, these in turn being clamped by the screws *H* and *J*. Whether the tool will prove to possess such practical qualities as will insure for it any extensive application is difficult to say, but the idea is ingenious, and may be applied in other cases than that of cutting square screw threads as well.



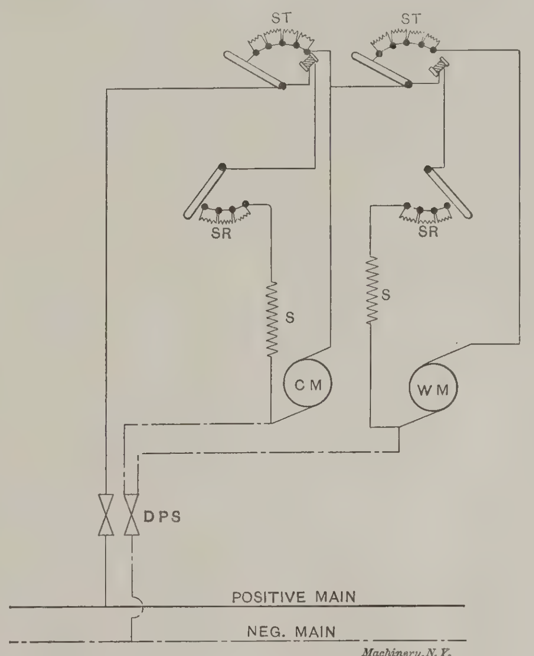
Adjustable Chasing Tool for Cutting Square Threads.

WIRING FOR MACHINES REQUIRING TWO MOTORS.

An electrically-driven thread miller, built by Drummond Bros., Ltd., of Gilford, England, is described in the European edition of the *American Machinist* of May 25, 1907. Two motors are used on this thread miller, one of them to rotate the cutter and the other to turn the work and feed it at the proper rate to give the spiral desired. This arrangement is obviously a good one, so far as doing away with the complicated mechanical connection is concerned. The cutter spindle can be easily swiveled to any angle desired without requiring the power which drives it to be transmitted through bevel gears, universal joints, and other devices of the kind.

There is one difficulty met with, however, in having no mechanical connection between the cutter spindle and the work spindle. If for any reason the cutter spindle stops from burning out of the motor, sticking of the cutter, or other mechanical or electrical reason, there is nothing to prevent the motor driving the work and feed mechanism from still going ahead to the damage of the work and cutter at least, and probably of the machine.

To make such a condition impossible the wiring connections shown in the cut are used. The work driving motor *W M* is wired through the last resistance contact of the left-hand starting switch belonging to the cutter driving motor *C M*. The release of the feed starting switch is tripped on the stoppage of the cutter motor, and, besides, it is impossible to start up the work motor until the starting switch of the cutter motor has been brought to the operative condition. If the cutter motor fails from over-loading, short circuiting or other defect, the automatic release of the starting box will throw back the starting switch and stop both mechanisms.



Wiring Arrangement for Machines requiring Two Motors.

This arrangement was the result of evolution. In the machine as originally designed, with a single motor drive, four changes in direction were necessary in the gearing, and although various forms of driving rod (including a square rod with four rollers, one on each side) were employed for transmitting motion, a considerable amount of power was wasted. Thus in this latter design each motor is of but ½ horse-power rated capacity, whereas in the earlier machines a two-horse-power motor was needed. For automatically stopping the machine at any point a tumbler switch is employed, this being simply clamped on the front of the machine in any position, cutting out both motors at the same time.

* * *

Rubber belting is ordinarily figured as averaging 1-16 inch thickness per ply. Thus a 7-ply rubber belt is about 7-16 inch thick, and corresponds in thickness to a heavy double leather belt. The permissible working load for average conditions may be taken as about 11 pounds per ply per inch of width, hence a 7-ply rubber belt 10 inches wide should safely carry $7 \times 11 \times 10 = 770$ pounds maximum working tension. The coefficient of friction should be figured about the same as leather, or say 0.3. Reuleaux limits it to 0.25. However, a still higher coefficient than 0.3 is frequently used for both leather and rubber belting in good condition and working under favorable circumstances.

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A SPECIAL EDITION OF MACHINERY FOR THE RAILWAY SHOP, DEVOTED TO LOCOMOTIVE AND CAR EQUIPMENT AND MECHANICS.

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We solicit communications from practical men on subjects pertaining to railway machine shop practice, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

AUGUST, 1907.

CAUSE OF LEAKY LOCOMOTIVE FLUES.

In another part of this issue is given an installment of a valuable paper by Mr. M. E. Wells on the causes of leaky flues in locomotive boilers. This paper, we believe, is well worth careful reading by every railway man interested in locomotive boiler construction and up-keep. The influence of feed-water temperature in boiler deterioration has not received as careful attention as it should. The conclusion that excessive difference of temperature in a boiler, due to the injection of feed-water, is a cause of boiler troubles, is, of course, nothing very new, but that cold feed-water is *the* cause of the majority of boiler troubles is, we believe, a new idea—with American railway men at least. The contention that the passage of air through the flues, when the fire door is open or the fire becomes thin, is not a serious factor in producing leaks will be considered a rank heresy by many, perhaps. No doubt the passage of cold air through the flues *does* contribute to boiler troubles, but, as the paper points out, there is little possibility of the air reducing the temperature of the flues greatly when not badly scaled. The contention seems sound, and we believe that the effect of cold air in causing flue troubles has been greatly overestimated.

The inevitable conclusion forced upon those interested in locomotive boiler construction and maintenance is that, if we would avoid the majority of these troubles, we must provide means of warming the feed-water prior to injection in the boiler, or, if this is impracticable, to arrange our boilers so that it will be heated up in the boiler before it is distributed throughout its length, especially around the fire-box.

* * *

MERITS OF LOCOMOTIVE VALVE GEARS.

A report on the advantages of different valve gears for locomotives was made by a committee (Mr. C. A. Seley, chairman) at a recent meeting of the Master Mechanics Association convention at Atlantic City. As regards the Stephenson link motion it was the opinion of the committee that we cannot lower the standard of efficiency set by the Stephenson link motion, and that no other gear, so far, has demonstrated the ability to show better steam distribution than this valve gear. But, the difficulties of properly caring for the Stephenson gear on large locomotives having many wheels have made it imperative to adopt some other gear which is readily accessible. This condition is admirably met by the Walschaerts valve gear which is entirely outside the wheels, and this is perhaps the chief reason for its rapid growth in popularity since the advent of extremely heavy locomotives. The doing away with eccentrics and straps eliminates the sources of a large list of engine failures. More room is gained for proper bracing of the frames, a condition that contributes to reduced frame breakage. The report states that on heavy engines the weight of all moving parts of a link motion, from the eccentric straps through to the valves, is so great as to contribute to accidents and rapid wear. But notwithstanding the reduction of weight with a Walschaerts valve gear, there is an increase of total weight of about 1,000 pounds due to the difference in design of other parts, as was pointed out in an editorial note published in RAILWAY MACHINERY some months ago. The report also discussed the Young valve gear and the Allfree-Hubbell design without expressing any particular opinion as to the merits of either.

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THE GYROSCOPE IN SHIPS, CARS AND FLYING MACHINES.

The gyroscope is attracting much attention at the present time because of its application by Herr Schlick to the reduction of rolling of vessels, and by Mr. Brennan, of London, to the balancing of his monorail car. The Schlick gyroscope (described in the May, 1904, issue of MACHINERY) is an interesting device, and according to the results published in the *Zeitschrift des Vereines Deutsche Ingenieure*, it is very successful in operation. A 115-foot torpedo boat of the German navy has been fitted out with the Schlick apparatus. The revolving wheel is a solid block of forged steel, 3 feet 3¾ inches diameter and weighing 1,100 pounds. This wheel is driven at 1,600 revolutions per minute by a steam turbine mounted on the same shaft. The revolving wheel is mounted in gimbals so that the wheel and frame are free to oscillate in a plane parallel with the keel. A test showed that the apparatus reduced the rolling of the vessel from a maximum of 15 degrees to from ½ to 1 degree. Contrary to predictions the vessel was not strained by the waves nor did it ship heavy seas. The first application of the Schlick apparatus to a ship was, we believe, on one of the Hamburg-American steamers built at Stettin. (See MACHINERY, May, 1905).

Notwithstanding the success of the gyroscope in reducing the rolling action of vessels, it is difficult to see how the Brennan apparatus, which sustains a monorail car in a vertical position, can be of much value for railways. In the case of a vessel, the seaworthiness is no worse than that of an ordinary vessel when the gyroscope is not in operation, and in case of break-down its loss would not be a serious matter, or at least would put the vessel in no worse predicament than if it were not so equipped, but in the case of the monorail car, which is entirely dependent on the gyroscope apparatus to maintain its equilibrium, any failure of that apparatus would mean the derailment of the car and, perhaps, cause a wreck of the whole train. It seems that notwithstanding the favorable comments this invention has received, it can be little more than an ingenious toy designed to arouse the curiosity of people who may gather at fairs, seaside resorts and other places where idle folk are wont to congregate. Should the aeroplane or other heavier-than-air flying machine ever develop to a practical state, it might be that a valuable contribution to its stability would be some form of the gyroscope, and it may be that the Brennan apparatus described in another part of this issue will be of much more value in this field than in that of railroading.

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It is mentioned in the *Engineering News* that a third rail interurban line is to be built in California, to be known as the California Midland Railroad, having a total mileage of 70 miles. The feature of interest to engineers is the under-contact third rail employed, which carries direct current at 1,200 volts; this high voltage makes possible the use of a rail of smaller section than those in conventional use, the one proposed being of special section in the form of an inverted T and weighing but 22.4 pounds per yard; it will be of special low-carbon steel. It will be supported by wrought-iron stirrups, keyed to the web and suspended from porcelain insulators. The insulators will be carried on iron brackets mounted on the ends of the ties. A wood covering will form the protection from the high voltage in the rail.

INTERCHANGE OF IDEAS A CAUSE OF PROGRESS.

In commenting upon the appearance of the new technical trade journal, *Werkstatts Technik*, the first one of any promise in Germany devoted exclusively to shop practice, the *Zeitschrift des Vereines Deutscher Ingenieure* finds occasion for a timely remark in regard to the causes which have made it possible for us in this country to distance Germany in the field of shop practice publications, although the latter country is one well known for its extensive use of printer's ink. It is pointed out that one of the most influential factors in the development of American industries has been the number of trade journals, and the free exchange of ideas and information which has taken place through these mediums. In Germany, on the other hand, it is stated that the shops have treated their methods as secrets and have been unwilling to give publicity to any of their experiences. The German writer in question freely admits that he thinks the superiority of American shop practice over that of German practice has been largely due to this fact, and points out how, as a rule, in America the shops are open to publicity, and that the principle is widely recognized that, without exchange of ideas, little progress is possible. This principle has also carried with it a willingness on the part of employers to either permit their employes to give publicity to their experiences in trade journals, or to permit representatives of trade journals to visit and gather information in the shops.

There is no doubt but that our German friend is perfectly right when he thinks that a great deal of the progress of American machine shop practice is due to free exchange of ideas, but on the other hand one must regret to observe that it appears as if American manufacturers in some cases at the present time were drifting into the German practice of considering a great deal of what is taking place in their shops as trade secrets. It may be argued that this attitude has been forced upon some concerns by the present-day competition, but it cannot be denied that concerns who stimulate the idea of keeping all their information to themselves, and considering their processes as trade secrets, while for the time being they may prosper by so doing, will in the long run be recognized as factors in retarding the progress of American industries. Inasmuch as there is no more certain way toward success for the whole nation in its endeavors to retain its supremacy, particularly in machine design and machine building, than a free, and we feel inclined to say, unlimited exchange of ideas, data and experiences, one must greatly regret to see a reaction in this respect. The Germans, having realized that publicity has been one of the strongholds of the excellent American shop practice, have of late greatly receded from their former attitude of secrecy, and it would be deplorable if, at the same time as the tendency there is toward the adoption of such practices as have, at least partially, caused our supremacy in this country in the past, we ourselves should enter upon the same road as they have found to be unprofitable, not only for the nation as a whole, but as an inevitable consequence, in the long run to each individual concern as well.

* * *

POSSIBLE INCREASE OF BOILER CAPACITY.

Experiments now being conducted by the boiler division of the United States Geological Survey fuel-testing plant at St. Louis, Mo., on the nature of boiler efficiencies have suggested that stationary boilers ought to be made to do *ten to twenty times* as much work per unit of heating surface as they do now. This great increase in capacity is to be attained by subdividing the heating surface and water streams more finely, by allowing less restriction of the water inside the boilers, and by using high forced and induced draft to put a large mass of gases through the boiler at a very high speed.

Up to the present time there have been only vague ideas among engineers as to what factors influence the efficiency of the steam boiler portion of the steam generator apparatus so as to cause it to absorb more or less of the heat generated by the combustion. Mr. John Perry, a distinguished mechanical and electrical engineer of England, went into the subject mathematically a few years ago and set forth general conclusions tentatively in his book "Steam Engine, and Gas and Oil Engines."

About a year ago, the government testing plant took up the mathematical investigation of the theory of the steam boiler and of heat absorption, and extended Mr. Perry's theory somewhat. For some weeks past, Mr. Walter T. Ray, assistant engineer, acting under the supervision of Prof. L. P. Breckenridge, engineer-in-charge of the boiler division, has been conducting a series of experiments on small multi-tubular boilers dimensioned so as to enable the theory to be verified, or modified, or refuted. The boilers are fed with air, heated electrically. Mr. Perry's theory states that modifying conditions being omitted from consideration, every boiler will always absorb, by convection from the gases passing through it, the same percentage of heat which could possibly be absorbed by any boiler containing water at a given steam temperature. This efficiency is, therefore, independent of the temperature of the entering gases and of the amount of gases flowing through the boiler.

As a practical example, assume that the water in a boiler circulates with entire freedom, which is an unwarranted assumption, and that its temperature is 300 degrees F.; let the gases enter the boiler at 1300 degrees F., then the difference between the two is 1000 degrees F., and consequently it would be possible for a boiler infinitely long to reduce the temperature of the gases passing through it to 300 degrees F. Let us assume, however, that the gases leave the boiler at 500 degrees F., which is 200 degrees above steam temperature. The efficiency of the boiler then is 80 per cent, because it has reduced the temperature 800 degrees out of a possible reduction of 1000 degrees.

If the same boiler be supplied with gases at 2300 degrees F., the gases enter the boiler at 2000 degrees F., above steam temperature. Mr. Perry's theory states that this particular boiler will reduce these gases in temperature 80 per cent as compared with a boiler infinitely long; that is to 400 degrees above steam temperature, which is 20 per cent of 2000 degrees, or to 700 degrees F. It will be noticed that the mass of gases does not enter into consideration at all.

This surprising deduction is being accurately verified by the Geological Survey fuel-testing plant, from which it is found, when keeping other conditions the same, and when keeping the initial temperature of the gases constant, that the final temperature of the air remains the same, whatever the amount of air sent through the boiler per second. So far the upper limit has not been reached with tubes clean inside and out, although the rate of evaporation has already been pushed up to many times that obtained even in locomotive practice.

Perry's theory takes into consideration four fundamental features affecting heat absorption at any point of the heating surface:

1. Temperature difference between the gases outside any portion of the boiler tube and the water inside.
2. The number of molecules per cubic inch in the gases outside the boiler tube.
3. The specific heat of the gases at constant pressure.
4. The velocity of the gases parallel to the heating surface.

Of the four above factors, only the first has usually been considered. It will be readily seen that if we increase the temperature of the gases, we decrease the number of molecules beating against any square inch of tube heating surface, and thus the second factor largely neutralizes the first.

The third factor can be taken as a constant equal to 0.24.

The fourth factor is the new and surprising one. Mr. Perry considers that a high velocity of gases parallel to the heating surface scrubs off more or less of the dense film of gases adhering to the metal surface, which film of gases has already become cold by proximity to the metal. The higher the velocity of gases, the more the scrubbing effect, and consequently the greater the amount of heat transmitted. This theory necessarily assumes that the ability of the metal to transmit heat is practically infinite, and when we consider that we ordinarily never put through a boiler tube more than 1/1000 of the heat it could carry, this assumption is warranted.

Mr. Perry's theory and the Survey's verification of it will result in placing the steam boiler on a fairly secure mathematical basis, the same as are now generators and motors. Thus far the experiments check out the theory excellently.

ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

The machinery of the new Cunard liner *Lusitania*, of which a general description was given in the August, 1906, issue of MACHINERY, is now all complete, and the vessel has left the shipbuilding yards for her trial trips on the river. The maiden voyage across the ocean is expected to be made early in the fall.

Consular reports indicate that the British government's trials with automatic stamp selling machines have proved successful. The machine tested is so perfect in its mechanism that it eliminates all bad coins, whether they be bent, counterfeit, or foreign. Another advantage of the invention is that no lever or handle has to be manipulated, the machinery being worked entirely by the weight of the coin.

During the month of June one of the greatest engineering projects of the times was commenced near Cold Spring, New York, west of the Hudson River. Enormous reservoirs are to be constructed in the Catskill mountains, and an aqueduct is to bring the water from there to the city of New York, a distance of about 100 miles. The work is estimated to cost at least $160,000,000, and will add 500,000,000 gallons daily to the present New York water supply.

A motor vehicle has been built in France, says the *Horseless Age*, which is suitable to run on both land and water. In other words, the vehicle is a motor boat mounted on wheels, the latter being of disk type and fitted with solid rubber tires. When entering the water, the motor is connected with a propeller. The hull is 13 feet long, and the maximum speeds obtained are 22 miles per hour on land and 6 miles per hour in water.

Experiments lately carried out in Vienna to introduce a system of regulating public clocks by means of wireless telegraphic impulses, have, it would seem by an announcement in the *Neue Freie Presse* of May 18, proved successful. A clock regulated on this principle was tested and was found to be wholly uninfluenced by stray currents, and kept perfect time in accordance with the regulating clock, 3.72 miles distant, which controlled its movements by wireless telegraphy.

Hot-water heating with mechanical circulation of the warm water is, according to the *Engineering Record*, being installed in connection with a gas engine plant in a small factory near New York. The factory will require about 400 H.P. in gas engines, and arrangements will be made to utilize all the heat in the jacket water and exhaust gas, practically 50 per cent of the heat furnished to the engine, for warming. Supplementary boilers will be installed for use at such times as these waste sources may furnish insufficient heat.

That the industrial future of a nation is largely dependent upon the placing of the control of its natural resources in the hands of the public, is becoming more and more recognized, and many nations have already commenced to act on this principle. The *Cologne Gazette* states that Switzerland has decided to place the control of the country's water-power in the confederate government, for the purpose of safeguarding the public's right in these natural resources as well as insuring the future industrial development of the country along equitable lines.

It is stated by the *Canadian Engineer* that there is a project on foot for the construction of a second canal at Suez, supported solely by British capital. The project, it is said, has taken definite form, and the British government is expected to grant a concession for the construction in the near future. The tolls charged by the French company controlling the present canal have long been claimed to be extortionate, and, as the British are the ones who use the canal most extensively, it is natural that they should try to get control of a canal of their own to further their shipping interests. It would seem, however, as if the plans to construct a new canal were largely of the nature of a gigantic bluff to bring the old company to terms.

The plans for the New York Connecting Railway Co.'s new bridge over Hell Gate, New York, have recently been approved. This bridge will connect the New York, New Haven & Hartford R. R. with the Pennsylvania system, the connection being made in Brooklyn. The bridge will form a part of a steel viaduct more than three miles long, the bridge itself being of arch construction, the main span being 1,000 feet between abutments. Eighty thousand tons of steel will be used in its construction. It will carry railroad tracks on stone ballast so as to render the structure noiseless.

One year's service with the steam turbine propelled Cunard liner, the *Carmania*, has shown results in excess of expectations. During the entire year the turbines have not been opened or needed any unusual attention. When the ship was first placed in service, the turbines were run only at a moderate speed as a precautionary measure, with a result that a rather low efficiency in operation was secured. On later voyages, the turbines have been speeded up, and it is interesting to note that the coal consumption is now almost identical with that which might be expected from the best quadruple expansion engine construction.

The use of vanadium is proposed in rail metal in order to prevent the frequent breakages. The use of vanadium in steel metallurgy is at present attracting much attention, and the great improvements in the mechanical qualities of steel, due to the introduction of this metal, are being recognized. Vanadium permits the even distribution of carbon, and retards constitutive segregation. The quantity of ferro-vanadium alloy required to produce the desired results is so small that the cost of the steel product is but little increased thereby, whereas the advantages resulting from its introduction could hardly be overestimated.

In the Engineering Review section of the July issue of MACHINERY mention was made of the need of imparting business education to engineers as well as technical knowledge, quoting an institute in Germany which makes a feature of giving instruction in bookkeeping, etc. In connection it was suggested that it would be highly commendable if higher technical institutions in this country would adopt the same idea. The note should properly have mentioned the notable exception of the Worcester Polytechnic Institute which makes a feature of giving its students some knowledge of practical commercial conditions of engineering. An article on shop management was contributed by Prof. Wm. W. Bird to the May issue of the *Worcester Polytechnic Institute Journal*, which is well worth perusal by those interested in this educational feature.

From Germany comes the news of a new composition to take the place of cedar as a material for the body of lead pencils. This material forms a pencil of compact composition, the main ingredient of which is potatoes. The invention is said to have been perfected, and the pencils are being manufactured in large quantities preparatory to being placed on the market. The United States Consul of Magdeburg, who sends in this information, says, that while these pencils are somewhat heavier than cedar, they are the same in size, form and appearance as those at present used, admit of sharpening a little more easily, and can be produced at a very low price. We have had occasion a number of times to note the ability of the Germans in making use of strange materials as substitutes for others better known and longer used. Perhaps, if there were any necessity for it, they might even be able to accomplish the proverbially difficult task of making a silk purse out of a sow's ear.

The increased use of large gas engines is shown by some figures given in the *Iron Age*, according to which there is at the present time 380 gas engines in use in Germany of 500 horse-power and larger, the average of each engine being 1,108 horse-power. The largest unit yet built is probably a 5,000 horse-power gas engine of Erhardt & Senmer, which has four cylinders 45 x 51 inches, and operates at 90 revolutions per minute. At present 29 firms in Germany build large gas engines, and of these 21 build double-acting four-cycle, 5 build two-cycle, and 3 firms build both systems of engines. Undoubtedly large gas engine units have so far been given greater attention in Germany than in the United States, but there is no question that their advantages are being recognized over here as well. One establishment alone in Germany has 35,000 horse-power of gas engines running, and there are two central power stations under construction which are to employ gas engines for generating electric energy for lighting and street car service. These stations will, when completed, have 50,000 horse-power of gas engines each.

It has been proved by Dr. Paul Heyl, of the Philadelphia Central High School, that visible and invisible light rays travel at the same rate. Dr. Heyl thereby won the Uriah A. Boyden prize of $1,000 deposited with the Franklin Institute in 1859. The offer of a prize has been published in each monthly issue of the *Journal of the Franklin Institute* for the past 48 years, and though a considerable number of essays have been read containing alleged proofs, none has proved satisfactory until the demonstration of Dr. Heyl. The method he employed was ingenious and simple, although the experiments required about two years' time and a great many tests. It was done by photographing the light of the star Algol, which is noted for its periodical variation in brightness. Photographs of the ultra-violet end of the spectrum were made through a refraction grating, this end of the spectrum being selected because the ultra-violet rays are invisible to the eye. Photographs were taken with 20-minute exposures at intervals of a half hour for six hours, which period is the time required for the fading and recovery of the light of this variable. It was found that the photographs changed in intensity according to the periods of intensity of the star as seen by the eye. In this way the coincidence of velocity of the visible and invisible rays is considered to be proved.

THE A. L. A. M. HORSE-POWER FORMULA.

At the last meeting of the mechanical branch of the Association of Licensed Automobile Manufacturers, which took place in Hartford, Conn., May 9, a horse-power formula was adopted which is to be used in the rating of automobile engines. In the formula adopted, D represents the cylinder diameter, and N, the number of cylinders. The formula adopted is

$$\text{Number of horse-power} = \frac{D^2 \times N}{2.5}$$

By means of this formula the following table, taken from the *Horseless Age*, has been calculated:

Bore of Cylinder, Inches.	Number of Cylinders. 1.	2.	3.	4.	6.
	Horse-power.				
3	3.6	7.2	10.8	14.4	21.6
3.25	4.2	8.4	12.7	16.9	25.3
3.50	4.9	9.8	14.7	19.6	29.4
3.75	5.6	11.2	16.9	22.5	33.7
4	6.4	12.8	19.2	25.6	38.4
4.25	7.2	14.4	21.7	28.9	43.3
4.50	8.1	16.2	24.3	32.4	48.6
4.75	9.0	18.0	27.1	36.1	54.1
5	10.0	20.0	30.0	40.0	60.0
5.25	11.0	22.0	33.1	44.1	66.1
5.50	12.1	24.2	36.3	48.4	72.6
5.75	13.2	26.4	39.7	52.9	79.3
6	14.4	28.8	43.2	57.6	86.4

It will be found that this formula, although it differs somewhat, is principally the same as the horse-power formulas by Mr. Dugald Clerk, which were published in the Engineering Review section of the January issue, this year.

EFFECT OF HIGH TEMPERATURES ON LUBRICATION.

W. K. Jervis, in the *American Machinist*, May 9, 1907.

Experiments were made for the purpose of determining the effect of higher temperatures than ordinarily occur, upon the friction set up in a given bearing by the oil film between the rubbing surfaces, pressure and speed being maintained constant. The oils experimented upon were common lard and machine oils, such as are used for cutting and lubricating purposes. The results obtained are doubly interesting because of the rather extreme conditions of pressure, speed and temperature under which the test was made, and because of the remarkable regularity with which the points, when plotted, fall on a smooth curve.

A Kingsbury oil testing machine was used, in which a vertical spindle ran between two opposed brasses in a bath

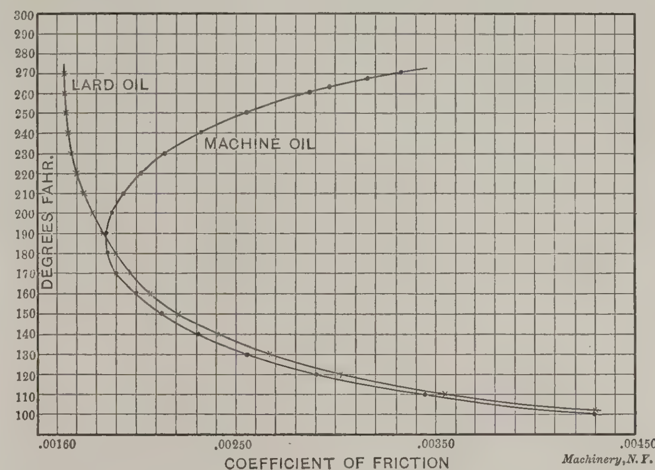


Diagram showing Result of Lubricant Tests.

of the oil under test, which was contained in a surrounding cylindrical case. The load on the bearing was applied by a heavy helical spring, passing through the side of the case and adjusted by a screw.

The oil case and its attachments were mounted upon a hollow vertical spindle, free to turn on the frame of the machine. The moment of friction of the journal tending to rotate the case was balanced by the torsion set up in a tempered steel wire by which the hollow spindle was supported, and the displacement of the case was read off in degrees from a circular arc on the frame of the machine. Heat was applied to the case and contents by means of a gas flame.

The results are shown in the accompanying curve. Up to about 180 degrees F. the coefficients of friction of both the lard and machine oils run very nearly together, the difference being about 3 per cent in favor of the machine oil. As the temperatures increase, producing a corresponding decrease in the viscosity of the oils, the curves show that the friction coefficients become less, reaching a minimum at 190 degrees for the machine oil, but continuing to decrease as much as 10 per cent more with the lard oil, the curve becoming nearly asymptotic to the temperature axis and showing no sign of change up as high as 280 degrees.

Evidently above 190 degrees the machine oil disintegrates, and the film between the bearing surfaces begins to break down; hence the friction increases very rapidly with the temperature.

A TWO-GAGE TRAMWAY TRUCK.

Tramway and Railway World, London, May 2, 1907.

The fact that different cities in England have adopted different gages for their street railway systems frequently makes it impossible for the two systems of neighboring towns to connect for the cars to be routed through. Such a condition exists at the two towns of Bradford and Leeds, the street railway systems of which connect. To make possible the running of a single car on the systems of both towns, C. J. Spencer and J. W. Dawson have designed a truck in which the gage is adjustable, enabling a single car to run on both sets of tracks. Two types of truck have been designed. On one of these the wheels and gears are mounted on sleeves which may slip along the axle. They are held in the extreme position by

means of locking blocks. As the car approaches the junction of the two tracks, the locking blocks are raised, and as it proceeds along a tapered section of the track, the wheels automatically change from one gage to the other. The blocks are then dropped, locking the wheels in the new position. In the other design the axle is divided at the center, and is itself adjustable axially. The running wheels and the gear are mounted rigidly on those two short axles, which are supported by means of boxes at the sides of the truck and by two additional boxes carried on brackets near the center. In both of these designs each motor is fitted with two pinions long enough to allow for the shifting of the gears. The change in gage is from 4 feet to 4 feet 8½ inches. A truck constructed according to the first design has been tried recently, and is said to have given satisfaction.

FORMULAS FOR GAS ENGINE FLY-WHEELS.

R. E. Mathot, in *The Engineering Magazine*, June, 1907.

The following formula for the calculation of fly-wheels for gas engines, is applied by Mr. R. E. Mathot to all classes of engines. If, in the formula,

$P =$ the weight of the rim (without arms or hub) in tons;
$D =$ diameter of the center of gravity of the rim in meters;
$a =$ the amount of allowable variation;
$n =$ the number of revolutions per minute;
$N =$ the number of brake horse-power;
$K =$ coefficient varying with the type of engine;

then, $P = K \dfrac{N}{D^2 a n^3}$.

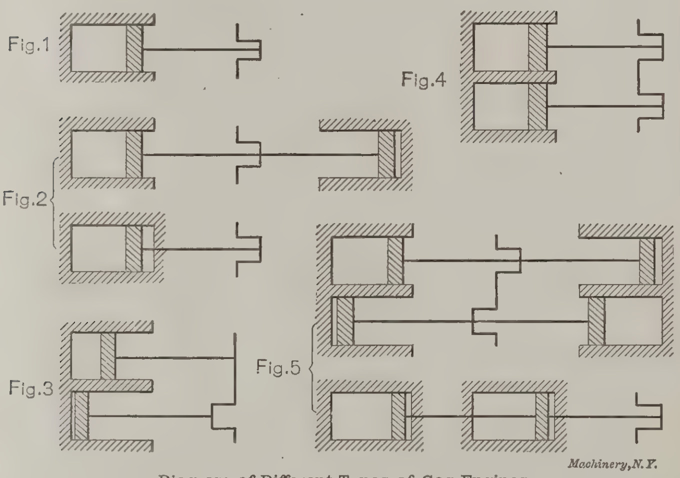


Diagram of Different Types of Gas Engines.

If D is transformed to feet, the formula will read:

$$P = K \frac{10.75\,N}{D^2 a n^3}.$$

The coefficient K, which varies with the type of engine, is determined as follows:

$K = 44{,}000$ for Otto-cycle engines, single-cylinder, single-acting. (Fig. 1.)
$K = 28{,}000$ for Otto-cycle engines, two opposite cylinders, single-acting, or one cylinder double-acting. (Fig. 2.)
$K = 25{,}000$ for two cylinders single-acting, with cranks set at 90 degrees. (Fig. 3.)
$K = 21{,}000$ for two cylinders, single-acting. (Fig. 4.)
$K = 7{,}000$ for four twin opposite cylinders, or for two tandem cylinders, double-acting. (Fig. 5.)

The factor a, the allowable amount of variation in a single revolution of the fly-wheel is as follows:

For ordinary industrial purposes..............	1/25 to 1/30
For electric lighting by continuous current....	1/50 to 1/60
For spinning mills and similar machinery.....	1/120 to 1/130
For alternating current generators in parallel..	1/150

The total weight of the fly-wheel may be considered as equal to $P \times 1.4$.

DIRECT LEAKAGE OF STEAM THROUGH SLIDE VALVES.

J. V. Stanford, in *Journal of the Franklin Institute.*

When the weight of steam used in an engine, as determined by condensing the exhaust, is compared with that computed from the indicator card, it is well known that there is considerable difference in the results. This difference between the actual and computed weights, commonly called "the missing quantity," and in some cases amounting to as much as 50 per cent of the steam used, is generally considered as being accounted for by condensation in the cylinder. The indicator card shows only the actual weight of vapor in the cylinder at a given time, taking no account of the steam which has entered the cylinder and has been condensed by transfer of heat to the cylinder walls. There is no doubt that a large part of the missing quantity may be charged up to cylinder condensation, but there is a possibility that some of it may be due to another cause, namely, valve leakage.

Experiments have been made at the Mechanical Laboratory of the University of Pennsylvania, to determine some facts in connection with leakage of slide valves. A set of tests was made on a 6-inch x 9-inch Sturtevant blower engine, driving a three-quarter housed centrifugal fan keyed direct to the shaft. The engine and fan had been installed in the boiler house of the university to create forced draft, and after a short period of use had stood idle with only an occasional run when used by the students for practice in valve setting. The engine has no governor, depending upon the throttle and the steady resistance of the fan to maintain the proper speed, and the valve is driven direct by the eccentric through a rocker arm. The valve is of the common D slide valve type, 5 inches wide by 4¾ inches long, overlapping the ends of the ports ¼-inch on either side. The engine had evidently been designed to work with the cut-off fixed at about 0.65 of the stroke, and during the tests the valve was set to give this cut-off. With this setting the minimum width of bridge covered by the valve was ⅝-inch, so that the exhaust port was everywhere protected from direct leakage by contact between the valve and seat at least ¼-inch in width.

A balance plate extends between the valve and chest cover to relieve the pressure between the valve and seat, and reduce the resulting friction. The balancing device consists of a cylindrical cup, bearing against a circular boss on the chest cover, and telescoping over a cylindrical projection from the top of the valve, the telescoping joint being made tight by two split rings. Contact is maintained between the balance plate and chest cover by four light springs. Steam leaking through the packing rings to the inside cavity of the balance plate is discharged through two 3/16-inch holes in the top of the valve direct to the exhaust cavity, so that the pressure over a large part of the valve is exhaust pressure. This leakage is also part of the missing quantity, for it goes to the condenser without affecting the indicator card.

In preparing for the tests, the engine exhaust was piped to a surface condenser, and arrangements made for collecting and weighing the condensation; a pressure gage was attached to the steam chest, and a revolution counter geared to the eccentric strap. Indicator cards were also taken. Two runs were then made with the engine working normally under the load of the fan, with the balance plate on the valve, and readings were taken to give weight of steam condensed, revolutions per minute, pressure in the steam chest, and the indicated horse-power. Average results from the two tests showed that the engine was developing about 5.13 horse-power, and was using about 91.2 pounds of steam per indicated horse-power per hour.

The balance plate was then removed from the valve, the holes through the top of the valve plugged with wood, leaving the valve unbalanced, and tests run as before. These tests gave a steam consumption of 60.5 pounds per indicated horse-power per hour, or 30.7 pounds less than when the balance plate was in place, due to the difference in leakage. In the first case the leakage was through the balance plate and under the valve; in the second case under the valve only, but the difference was probably due, not so much to leakage through the balance plate, as to the fact that in the first case the valve was only lightly seated, while with the balance plate removed it was seated firmly by the whole pressure of the steam, and a good joint maintained with the seat.

In order to determine the actual amount of leakage, the steam ports of the engine were plugged by driving in blocks of

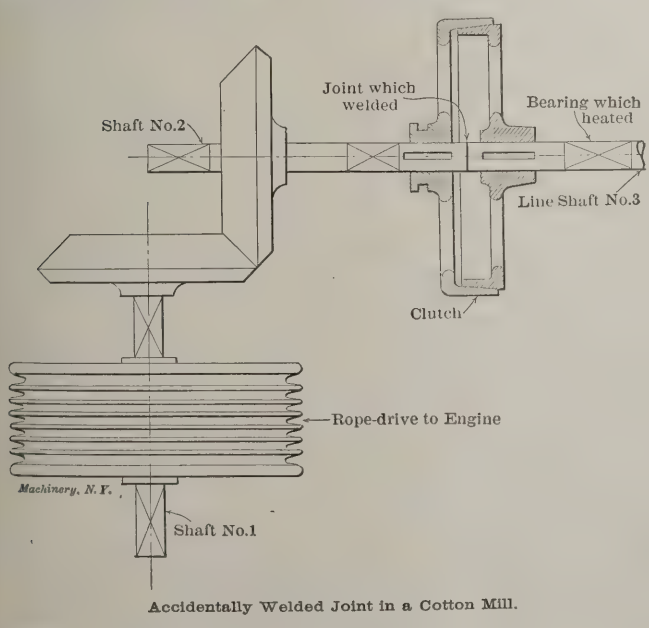
dry white pine, filling the steam passages flush with the valve seat. One cylinder head was then removed and the stuffing box opened to relieve any pressure in the cylinder due to leakage through the plugs. The eccentric sheave was loosened on the shaft and bolted to a large wood pulley placed beside it. The pulley was belted to a one-horse-power electric motor, geared to drive the pulley and eccentric about the shaft at the same speed as had been used in the previous tests. Having thus reproduced the conditions of the running of the valve as nearly as possible, except that all passages of steam to and from the cylinder were eliminated, it was fair to assume that all the steam now reaching the condenser was due to leakage from the chest to the exhaust, and that the amount was practically the same as when the engine was running normally. In running these tests, the motor was started and adjusted to the proper speed, then the throttle valve was opened carefully until the pressure in the chest was the same as in the other tests. A test under these conditions, with the balance plate on, showed the leakage amounting to 43.9 per cent of the total steam consumption.

As stated before, the engine had been standing idle for some time, and the valve and seat were not in perfect order, but their condition was not unusually bad, for when tested in the ordinary manner by opening the throttle with the valve standing still over the ports, only a trifling leakage was apparent, which makes it appear that the standing test for leakage, so commonly used, is a very poor index of what may take place when the valve is running.

In order to determine the effect of the balance plate in reducing the work required to drive the valve gear, the electric motor driving the eccentric was calibrated for efficiency and wattmeter readings taken, giving data for computing the power absorbed by the eccentric and valve under varying conditions. It was found that the power used with the balance plate on was 0.25 horse-power, and that it remained practically constant for varying pressures in the chest. Without the balance plate, the power required increased with the pressure and amounted to 0.38 horse-power for the pressure previously used. While the saving shown here is slight, the value of the balance plate for much larger valves is unquestioned, and no doubt results in a net saving when the parts are in perfect working condition, but it would seem that in a small engine receiving the ordinary care, its presence may become detrimental in the course of time, owing to its tendency to increase the leakage due to poor contact between the valve and seat.

A CURIOUS ACCIDENTAL WELDING OF STEEL SHAFTING.

A Russian correspondent of the *Scientific American*, in its issue of June 8, 1907, describes a peculiar accident which took



Accidentally Welded Joint in a Cotton Mill.

place in a large cotton mill near Moscow. From a steam engine of 1,500 horse-power, 350 horse-power is transmitted by a rope drive to one of the upper stories of the mill. The driven shaft makes 320 revolutions per minute. The motion is transmitted from the rope pulley to the line-shafting by a pair of bevel gears which, through a friction clutch, transmit the motion directly to the line-shaft of the mill. This arrangement is shown in the accompanying cut. By some mistake of the man who erected this rope drive, shafts Nos. 2 and 3 were put so closely together that they touched each other, and all the end pressure from the bevel gears was transmitted directly to the end of the line-shaft.

One morning, one of the bearings of the line-shaft became warm. The engineer, wishing to cool it, loosened the clutch and thus stopped it. Under these circumstances, all the pressure from the bevel gears rotating shaft No. 2 was applied to the end of the line-shaft. Both shafts were of the same diameter, about 6¾ inches. As this pressure was considerable, and the shaft was making 320 revolutions per minute, in a few moments the touching ends between the two halves of the clutch were heated not only to a red heat, but to the melting point as well, so that the liquid iron spurted to the walls. The engineer became very much frightened and signalled the engines to stop, and thus both the shafts became completely welded together. When they were cool, the engine was started again, but even with the friction clutch open, the full 350 horse-power was transmitted through this welded joint without breaking it. There was no further difficulty from hot bearings, owing to the fact that the shafts were welded in exact alignment. The shaft worked satisfactorily for over a month until there was opportunity to make the necessary repairs.

STEEL CASTINGS IN LOCOMOTIVE AND CAR CONSTRUCTION.

J. V. McAdam, in *Sibley Journal of Engineering*.

The increase of the use of steel castings in locomotive and car construction, as well as in machine building in general, is hardly realized by persons not directly in touch with the particular branches where these castings are used. The difficulty with steel castings is their liability to crack in cooling. For this reason brackets and ribs should be avoided wherever possible, as they tend to produce shrinkage cracks, on account of the extra thickness of metal and therefore slower rate of cooling where the rib joins the main casting. These cracks are often internal and do not appear on the surface. When the casting does not crack, it is liable to serious warping when cooling. Therefore it is often necessary to distort a pattern so that the finished casting will come out straight, as in the case of one which had a box-shaped end 6 inches deep and 13 inches wide. It was necessary to dish the top ⅜ inch in order that it might swell back straight in cooling.

Cast steel shrinks ¼ inch to the foot in cooling, being twice that of cast iron, and in a casting 20 feet long this amounts to 5 inches; it is therefore advisable to avoid, if possible, any large cross flanges or cores at the ends that will anchor the casting in the sand, and cause it to pull itself in two. The largest part of the shrinkage occurs at the point of recalescence when the matter is in a granular condition, neither liquid nor solid. In some cases thin ribs are cast on and chipped off when the casting has cooled. These thin ribs cool quickly, and are strong enough to hold the larger part of the casting together until it has set. If carefully designed, however, large castings can be made with perfect success. Large numbers of castings are now made which are 10 feet by 8 feet, and have no portion over ¾ inch thick. The greatest difficulty comes where thick and thin portions are wanted on the same casting, producing unequal cooling, which results in the first portion shrinking after the second has already set.

In designing steel castings, locomotive frames, and railroad cars, it is impossible to estimate the required strength with any degree of accuracy, for the reason that no one knows what the stresses are going to be with the moving loads. It is customary in freight car work to consider the dead load on a casting to consist of the weight of the car body, plus the rated capacity, plus 10 per cent overload. The casting is then designed with an ultimate factor of safety of from 6 to 8, which allows for the moving load. In some cases where the failure of the casting would be very serious, as in passenger car truck equalizers, the factor of safety is made even more.

The ultimate strength of cast steel varies from 70,000 pounds to 100,000 pounds, and the elastic limit is about half the ultimate strength with an elongation as high as 30 per cent. Tests would indicate that there is little difference, if any, between the value in tension and compression, but in all designing the tension side is made stronger than the compression in about the proportion of 6 to 5, for the reason that any defects in the castings are less serious in compression than in tension, and we can therefore afford to risk more.

Besides possessing high tensile strength, cast steel is tough and ductile, which makes it the ideal metal to resist shocks and carry heavy loads, and its general adoption in car and locomotive construction may be ascribed to its simplicity of design as compared with anything else, its lightness, and above all, its great strength.

PRINCIPLE OF THE BRENNAN MONO-RAIL CAR.

A. M. Worthington, in *Times Engineering Supplement*, June 5, 1907.

The Brennan mono-rail car includes an entirely new application of gyrostats in combination. The stability of the car depends, as the patent specifications show, on at least three distinct inventions: (1) The automatic calling into play of a force tending to accelerate precession, by the rubbing of the axle of spin as it rolls along a guide, an action which may be said to be borrowed from a spinning peg-top; (2) the regulation of the precession so as to leave the gyrostats, after any disturbance, always with their planes of spin parallel to the rail; (3) the combination of two linked gyrostats spinning in opposite directions, for meeting the exigencies of a curved track.

Foucault's Gyrostat.

To understand these points it is necessary to recall the behavior of Foucault's gyrostat. Let the diagram, Fig. 2, represent a heavy-rimmed disk with its spindle $O\ A$ horizontal. This spindle turns in a ring or frame $B\ A\ C$, pivoted about the horizontal axis $B\ C$, at right angles to $O\ A$, on the frame

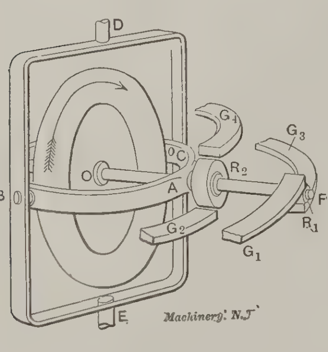


Fig. 1.

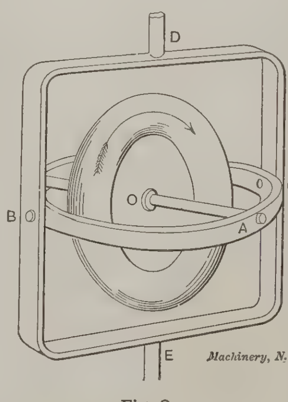


Fig. 2.

$B\ D\ C\ E$, which frame again is free to turn about the vertical axis $D\ E$. If the disk be not spinning, a downward pressure at A will cause A to descend with acceleration. If the disk be spinning slowly in the direction $B\ D\ C$, shown by the arrow, then A will not merely descend, but will move toward B, with rotation about $E\ D$, and a sudden removal of the pressure will leave the whole system violently oscillating.

If, however, the disk be spinning very fast, then we find that a downward pressure at A, maintained constant, produces no sensible depression of A, but creates what is called a precessional rotation of the spindle $O\ A$, at a constant rate about the axle $D\ E$, A moving toward B along the arc $C\ A\ B$, at a constant rate, so long as the rate of spin is unaltered. When the pressure ceases, there is only a slight and perhaps imperceptible tremor of the spindle $O\ A$, and we are left with the spindle displaced horizontally through an angle which is a measure of the time-integral of the couple that has been applied about the axis $B\ C$ as it moved.

If, on the other hand, with the disk spinning very fast, the pressure maintained at A is not vertical but horizontal, in the direction of the precessional rotation just described, then there will be no apparent revolution about $E\ D$, but there will be a rotation of the frame $B\ A\ C$ about $B\ C$, and A will rise, the angle through which $O\ A$ rises being in this case a measure of the time-integral of the moment of the pressure about $E\ D$.

If now, while we maintain a constant downward pressure at A, we also apply a constant horizontal pressure as if to accelerate the horizontal precession of the spindle, then the precession will not indeed be permanently appreciably accelerated, but A will rise at a rate proportional to the horizontal force, and work will be done by the horizontal and against the vertical force.

Brennan's Application of Foucault's Gyrostat.

These are the chief relevant physical facts which lay at Mr. Brennan's disposal and of which he has availed himself with such remarkable skill and success. We will endeavor to explain his arrangement by pointing out its relation to the Foucault gyrostat just described. In the first place, the frame $E\ B\ D\ C$ is pivoted on the body of the car at E and D, so that when the car is erect $D\ E$ is vertical. Mr. Brennan then makes the spindle of his disk into the armature of an electromotor, whose field-magnets are carried by the pivoted and still balanced frame $B\ A\ C$. When everything is in equilibrium and the car is running erect, the spindle $O\ A$ is horizontal and at right angles to the rail. We will suppose the car to be running in the direction $B\ C$, and will refer to A as the right-hand end of the spindle.

Now let a wind pressure be applied to the left side of the car. The car begins to turn over relatively to the gyrostat, and thus at once brings down a guide-plate G_1 (see Fig. 1) fixed to the car, and bent into a circular arc as shown, so as to press on a small roller, R_1, turning loosely about the end F of the spindle $O\ A\ F$, which now projects beyond the frame $B\ A\ C$. The pressure on this roller causes the spindle to precess from A toward B with an angular velocity proportional to the pressure, and the turning-over of the car is arrested, but at the same moment the friction between the rotating spindle and the roller makes the latter roll along the under side of the guide plate, and thus evokes a horizontal frictional force on the spindle, tending to accelerate precession. This causes the end F of the spindle to rise and push back the car against the wind pressure. Thus the car turns over to meet the wind, and is carried over beyond the vertical (perhaps considerably beyond) to a new inclined neutral position at which the moment due to gravity just balances the moment of the wind-pressure. This tilted position is reached, however, with a certain momentum which carries the car beyond it. Up to the instant of reaching this position the moment of the wind pressure has been in excess of the opposite moment of the gravitational pull, and the impulse that has acted is measured by the angular displacement of the spindle along the guide. From the instant that the car swings past the new neutral position, the moment of the gravitative pull-over to the left exceeds that of the wind pressure, and the car turning over to the left lifts the guide-plate G_1 off the roller R_1, and the gyrostat is left to itself, till a very slight further tilting over of the car brings a second curved guide-plate G_2 (fixed to the car) to bear on the lower side of a second roller, R_2, fitting loosely on a non-rotating sleeve which is part of the frame $B\ A\ C$. This arrests the further turning over of the car, and the gyrostat begins to precess back, but this time there is no force accelerating precession, so that the car remains tilted a little beyond the neutral position, till the roller, R_2, in passing beyond the middle position, is carried clear of the end of the guide-plate G_2; the gyrostat is now left again to itself, but the car being released from the pressure of R_2 at once falls over a very little more to the left, and thus brings to bear on the bottom of the rotating roller R_1 the third guide-plate G_3. The spindle now begins to roll over G_3; its precession is accelerated by friction, and the roller R_1 pushes back the guide-plate, and with it the car, up to and beyond the new neutral position of equilibrium, when the turning moment on the car again begins to be reversed, and the car, being now pushed over by the wind to the right of this position, brings its fourth guide-plate, G_4, to bear on the roller R_2, so that further turning is arrested, and the spindle $O\ F$ precesses back to the middle position. In this way, the oscillations

about the new neutral tilted position quickly diminish, and by thus arranging that the car shall overshoot the mark and then return in oscillations of diminishing amplitude, the time-integral of the upsetting couple is reduced to zero, which is the condition that the spindle shall be left at rest in the middle, or "ready" position, after any adjustment. Each time the car has to move toward a new neutral position of equilibrium, work is done at the expense of the energy of spin of the disk; this, and the energy lost in frictional heat, is made up by the battery which maintains the rotation of the disk.

It is evident that, instead of an upsetting couple due to wind pressure, we may have one arising from a lateral shift of load on the car. The same process of self-adjustment will be gone through, the car inclining itself to the left if the shift of load is to the right; just as a man carrying a load on his right shoulder leans over the left till the center of gravity of his system is brought vertically over the supporting base formed by his feet.

Provision for Rounding Curves.

We have spoken, so far, of only a single gyrostat, but it is evident that if we endeavor to travel around a curve the spinning disk will maintain its plane of rotation unaltered in direction, and the car carrying the guides will sweep them round past the end of the spindle *F*, and thus the middle position will be lost. To remedy this Mr. Brennan employs a second similar gyrostat with an equal disk, spinning at an equal rate in the opposite direction, about a spindle which, when all is in equilibrium, is parallel to, or, in fact, in line with, the spindle of the first disk. The pivoted frame *B A C* of the first is so linked to the corresponding frame of the second that any lateral tilt of the first is communicated to the second, but at the same time each of the disks is free to precess. The precession of the second disk is equal to that of the first, but in the opposite direction, and any deviation from this equality and opposition is prevented by toothed gearing which connects the axle *E D* of the first with the corresponding parallel axle of the second. Such a system offers no resistance to turning with the car on account of a curve in the track, while to any upsetting moment it behaves like a single gyrostat of double mass, and enables the car to meet the upsetting moment of the so-called centrifugal forces by leaning over toward the inner side of the curve, exactly as it leaned over to meet a wind pressure.

It should, however, be observed that this adjustment does not get rid of the force tending to displace the rail laterally, and that this can only be completely met by sloping the track on which the rail is laid with exactly the same super-elevation as is required in an ordinary railroad curve (a slope which depends on the velocity prescribed). Mr. Brennan gets rid of the danger of upsetting, but not of the need of providing against displacement of the rail.

It remains to examine what will happen when we pass from a model to a car of larger dimensions. Fortunately the result works out very favorably, since we find that if we take the linear dimensions of everything n times greater, we can afford to spin the gyrostats n times slower, and yet secure the same righting effect, with the same angular movement and return of the spindle along the guides.

This result is of great importance, for it means also that the centrifugal stresses in the real gyrostats need not be greater than in the model, and that the rate of spin may be reduced from 7,000 per minute in the model to 875 per minute in a car of eight times the size. A greater rate in a smaller gyrostat is, however, a preferable option.

WINDMILLS.

R. M. Dyer, Seattle, Wash., in *The Iowa Engineer*.

A short historical review of the windmill used as a prime mover will be necessary to establish a basis upon which some of our later facts may be founded. Whether or not windmills were used prior to the tenth century is not clearly established. The type of wheel which we know as the "Dutch wheel" evidently developed about that time, and for 700 years held its own with but few variations. The "Dutch wheel," so called because used in such great numbers in Holland, consisted of a main shaft, supporting four radiating arms, carrying light framework to support the canvas or other sail material; the main shaft communicated the power when produced to the machinery, which usually consisted of a paddle wheel water pump, a millstone, or a stamp mill. These mills were turned up to the wind by hand power, sometimes the whole mill turned on a pivot, sometimes the upper half only, and later only the top of the mill, which carried the main shaft and windmill.

Earliest Improvements on Ancient Windmills.

The earliest effort to improve the operation of these mills is recorded in 1780, when a device for reefing the sails while in motion was made by Andrew Miekle. This device, as well as that of Sir William Cubett (1807), designed for the same purpose, was accomplished by the effect of centrifugal governors. To the last-named inventor belongs the credit of first using an auxiliary windmill set at right angles to the plane of the main wheel to keep the windmill headed up to the wind without the constant attention of the attendant.

A few windmills of the Dutch type were built in America. Two of them stand within a few hours' trolley ride from Chicago, but for the purposes for which such power could be best used, that of pumping water, a design of mill gradually developed in America, known as the "American windmill," being a small wheel 12 to 20 feet in diameter, almost filled with wooden slats. This style of mill held its own for many years in its crude form.

The Halliday Windmill.

Daniel Halliday made the windmill a safe and practical machine by inventing and perfecting a wheel, the sails of which were connected up in groups or sections, which pivoted under control of centrifugal governor balls, and thereby held the mill to a reasonably safe speed at all wind velocities. The Halliday interests were afterward taken over by the existing company, the United States Wind Engine and Pump Co., of Batavia, Ill. The Halliday method of governing had and has many imitators, but none seems to have equaled the original. Another favorite method of governing used by the early builder of windmills was the "solid wheel with side vane," a small vane being attached rigidly to the frame which carried the head of the wheel, which would turn the wheel edgewise or partly edgewise to the wind when acted upon by winds above normal velocities. Variations of these two methods of governing formed the basis of innumerable patents between 1860 and 1890, during which time the manufacture of wooden windmills flourished and the number of manufacturers increased to a score or more. The Leffel wheel, made at Springfield, Ohio, between 1880 and 1885, showed the first departure from seemingly fixed methods of regulation in having the wheel set off from the center line of the vane, thereby avoiding the use of the small side vane, the force of the wind acting directly on the face of the wheel to bring it out of sail as the wind velocity increased above normal. The wheel was made with a sheet iron wheel and with a wooden vane.

The Modern Windmill and its Development.

The actual development of the windmill wheel as we know it was due primarily to the work of Mr. Thomas O. Perry. Mr. Perry was and is a gentleman of scientific and mathematical attainments and had interested himself for some years previous to 1882 in the development of the windmill and other machinery used in agricultural pursuits. At this time a preliminary study of Smeaton's and Weisbach's theories convinced him that the data upon which their deductions had been made lacked thoroughness and completeness; that the assumptions upon which these formulas had been based were, in part, erroneous, and that the wheels which had been used to develop the empirical elements of their equations were poorly suited to produce satisfactory results. He, therefore, developed by strictly theoretical and mathematical means, a new set of formulas, and made several startling suggestions in reference to improvements in windmill design. It might be mentioned that instead of using the elements of pressure and velocity of the wind as the basis of his power formula he used the more rational factor "kinetic energy" of the air current intercepted by the wheel.

In 1883 a laboratory was fitted up by the Halliday Company in Batavia, Mr. Perry being placed in charge, to test out on an elaborate scale his theory in reference to the design of windmills, as well as also to test the forms of wheel that several others had suggested. The following points, which were fully covered by these tests and experiments were established by several thousand tests on many forms of wheels: Form of sail, necessity of a thin sail, angle of sail or "weather;" effect of various obstructions before and behind the wheel; effect of obstructions within the wheel, such as wheel arms, connecting members of the wheel, etc.; proper amount of sail surface, speed of wheel, relative to velocity of wind, and, in fact, every question which had arisen at that time bearing on the design of wind wheels.

Result of Perry's Experiments.

Experiments developed that the old flat wood sail was not as efficient as the curved steel sail; the angle of weather was chosen most favorable for a light wind, 4½ to 5 miles per hour being utilized with some efficiency. Any windmill will run in a high wind, but a well designed mill must work in a light wind. A mill that requires a ten-mile wind may run only four or five hours per day; a mill that will run in a five-mile wind will probably run eighteen hours per day in some localities. Experiments developed the fact that seven-eighths of the zone of interruption could be covered with sails; that more than this was detrimental, and that the gain in power in from three-fourths to seven-eighths of the surface was so small that the use of the additional material was not justifiable; that the sail surface should extend only two-thirds the distance from the outer diameter to the center; that a wheel running behind the carrying mast is not nearly as efficient as one running in front of the mast; that there should be the least possible obstruction behind the wheel; that to be efficient the velocity of the travel of the vertical circumference of the wheel should be from 1 to 1¼ times the velocity of the wind, hence the necessity of back gearing to reduce the pump speed to forty strokes per minute as a maximum, which is the limit of safety at which ordinary pumps can be operated.

Perry records that with his experimental wheel he actually developed 44 per cent of the kinetic energy of the impinging air current; however, if an efficiency of over 35 per cent is sought for, a comprehensive study of the physical elements entering into the absorption of the kinetic energy of an intercepted air current by a wind motor operating under the most favorable conditions of wind velocity, curvature of sail, amount of sail surface and travel of sail, will show that the high rate of sail travel becomes prohibitive if such wheels are to be considered in view of their cost and maintenance, either as a manufacturing possibility or as an economic motor.

Power of Windmills.

Theoretical demonstrations show that the intercepted area of air current varies as the square of the diameter of the wind wheel, and that the kinetic energy of the air, impinging on such an intercepted area, varies as the cube of the wind velocity; consequently, we might say that the power of windmills of the same type varies as the square of the diameter, and as the cube of the wind velocity. This is true within reasonable limits, but as the wheel is designed to give its best efficiency in low winds, say 10 to 15 miles per hour, we cannot expect that the same angle of sail would obtain the same percentage of efficiency in winds of considerably higher velocity.

The ordinary wheel works most efficiently under wind velocities of from 10 to 12 miles per hour. Such wheels will give reasonable efficiency in from five to six-mile winds, while if the wind blows more than 12 miles per hour, we will have power to spare. Our wheel must work in light winds, such being nearly always present, while the higher velocities only occur at intervals. Mills built for grinding purposes, geared mills, or power mills as they are called, when attached to a grinder, having a centrifugal feed, will develop power almost approaching to the cube of the wind velocity, within reasonable limits of such velocity, as their speed need not be kept down to a certain number of revolutions per minute, as in the case of the pumping mill.

Should this theoretical condition hold, the following table, showing the amount of power for different sizes of mills at different wind velocities, would apply. Figures show H.P.

Size.	5 miles.	10 miles.	15 miles.	20 miles.	25 miles.	30 miles.	35 miles.	40 miles
8 feet....	.011	.088	.297	.704	1.375	2.176		
12 feet....	.025	.20	.675	1.6	3.125	5.4	8.57	12.8
16 feet....	.045	.36	1.215	2.88	5.52	9.75	15.3	21.04

These figures have been proved by laboratory tests at velocities ranging from ten to twenty-five miles per hour, and more, by the Murphy tests on mills actually in use, which show very close relation at the wind velocities at which the mills are best adapted.

The Murphy figures are as follows:

Size of Mill.	10 miles.	15 miles.	20 miles.
12 feet	0.21 H.P.	0.58 H.P.	1.05 H.P.
16 feet	0.29	0.82	1.55

For higher wind velocities the Murphy values fall much under the theoretical values, but the range of velocities over which his experiments extend does not justify any change in the general law except inasmuch as common sense teaches us that theoretical conditions can rarely be attained in actual practice.

In view of the fact that a windmill does not work as efficiently in high winds as in winds under 20 miles per hour, my experience would lead me to believe that the following figures (H.P.) would be the probable extension of the Murphy tests:

Size of Mill.	25 miles.	30 miles	35 miles.	40 miles.
12 feet.	2.5	4	5	6
16 feet	4	6	8	10

A 20-foot mill would deliver approximately 50 per cent greater power than a 16-foot.

Modification in Speed and Size Required by Practical Conditions.

The foregoing tables must be translated with reasonable allowance for conditions under which wind wheels must work, and which cannot well be avoided, *e. g.*, pumping mills must be made to regulate off at a certain maximum speed to prevent damage to the attached pumping devices. The regulating point is usually between 20 and 25 mile wind velocities, so that no matter how much higher the wind velocity may be, the power absorbed and delivered by the wheel will be no greater than that indicated at the regulating point. Again, owing to the peculiar construction of geared windmills, the torque of the vertical shaft operates to prevent the mill from regulating off; consequently, when working, the mill is held up squarely to the wind, until the load imposed by the attached devices ceases to absorb all of the power which the mill will deliver. After this condition obtains, any increase in wind velocities causes the mill to regulate or turn out of the wind. The regulation point on such mills when loaded is, therefore, usually placed at wind velocities of from 30 to 35 miles.

Another subject which needs some consideration is the fact that while the power of a mill increases approximately as the square of its diameter, the weight of the machine increases approximately as the cube of its diameter.

It is useless to waste time in a discussion of the comparative merits of wooden and steel windmills, while giving due credit to the excellent workmanship and the extreme care in the selection of the material used on some of the old wood wheels which have stood so long in some localities as to have become historical landmarks. The wood wheel, as generally constructed, is an inefficient, short-lived affair, designed without reference to the principles of wind dynamics. Actual tests have shown that some wood wheels, under certain wind conditions, will give more power with every alternate slat removed, and on wood wheels having slats ½ inch thick and 3 inches wide, the efficiency of the wheel is reduced nearly one-sixth, merely from the action of the wind on the edge of the slat.

* * *

It is said to be extremely important to the proper setting of concrete, if the best results are to be obtained, that it be protected, while the process is going on, from the wind and sun, especially in dry, warm weather. The dry air will rob the sharp corners, and even the faces, of their moisture, and a later wetting is no remedy.—*Scientific American.*

IRON AND STEEL.*

Commercial iron and steel are metallic mixtures, the chief ingredient of which is the element "iron," that is, pure iron, of which they contain from 93 per cent to over 99 per cent. The difference between iron and steel is principally due to the composition and proportion of the remaining ingredients.

Iron ore is an oxide of iron (iron rust) containing from 35 per cent to 65 per cent of iron; the balance is oxygen, phosphorus, sulphur, silica (sand), and other impurities. The ore is charged in a blast furnace, mixed with limestone as a flux, and melted down with either charcoal, coke, or anthracite coal as fuel; the resulting metal is what is commercially known as pig iron, containing about 93 per cent of pure iron, 3 to 5 per cent of carbon (pure coal), some silicon, phosphorus, sulphur, etc. This pig iron is used in foundries for the manufacture of iron castings, by simply remelting it in a cupola without materially changing its chemical composition; the only result is a closer grain and somewhat increased strength.

The Puddling Process.

In the manufacture of wrought iron the pig iron is remelted in so-called puddling furnaces, by charging about ½ ton in a furnace, and, while in a molten state, it is stirred up with large iron hooks by the puddler and his helper, and kept boiling, so as to expose every part of the iron bath to the action of the flame in order to burn out the carbon. The other impurities will separate from the iron, forming the puddle cinder.

The purer the iron the higher is its melting point. Pig iron melts at about 2,100 degrees F., steel at about 2,500 degrees, and wrought iron at about 2,800 degrees. The temperature in the puddling furnace is high enough to melt pig iron, but not high enough to keep wrought iron in a liquid state; therefore, as soon as the small particles of iron become purified they partly congeal (come to nature), forming a spongy mass in which small globules of iron are in a semi-plastic state, feebly cohering with fluid cinder filling the cavities between them. This sponge is divided by the puddler into lumps of about 200 pounds each; these lumps or balls are taken to a steam hammer or squeezer, where they are hammered or squeezed into elongated blocks (blooms), and while still hot, rolled out between the puddle rolls into bars 3 to 6 inches wide, about ¾ inch thick, 15 to 30 feet long. These bars are called puddle bars or muck bars, and, owing to the large amount of cinder still contained therein, they have rather rough surfaces. The muck bars are cut up into pieces from 2 to 4 feet long, and piled on top of each other in so-called "piles" varying from 100 to 2,000 pounds according to the size product desired. These piles are heated in heating furnaces, and when white hot, are taken to the rolls to be welded together and rolled out into merchant iron in the shape of either sheets, plates, bars, or structural shapes, as desired. When cold, this material is sheared and straightened, and is then ready for the market.

After leaving the puddling furnace, wrought iron does not undergo any material change in its chemical composition, and the only physical change is an expulsion of a large portion of the cinder; the small cinder-coated globules of iron are welded together and the subsequent rolling back and forth will elongate these globules, giving the iron a fibrous structure, and the reheating and rerolling will drive these fibers closer together, thus increasing the strength and ductility of the metal.

Classes and Kinds of Steel.

The word steel, nowadays, covers a multitude of mixtures which are very different from each other in their chemical as well as physical qualities. The ingredient that exerts most influence on these variations is carbon. High grade razor steel contains about 1¼ per cent of carbon, springs 1 per cent, steel rails from ½ to ¾ per cent, and soft steel boiler plate may go as low as 1/16 per cent of carbon. Steel which is very low in carbon can easily be welded, but it cannot be tempered; when carbon is above 1/3 per cent, welding is more difficult and can only be done by the use of borax or some other flux, or by electric or thermit welding. Steel with carbon above ¾ per cent can be tempered, that is, when heated to red heat and then quenched in water or other liquid, it becomes very hard and can be used for tools of various kinds, such as saws, files, drills, chisels, cutlery, etc. In tool steel other ingredients are sometimes used to influence its hardness, such as nickel, manganese, chrome, tungsten, etc., the last named playing an important part in so-called "high speed steels," that is, steel tools that will cut metal at a high speed without losing their temper or hardness.

As stated above, pig iron and cast iron contain about 4 per cent of carbon, and wrought iron only a trace of it, while steel is between these two extremes. The manufacture of steel, therefore, refers principally to getting the right proportion of carbon. One method is to take pig iron and burn the carbon out of it, as in the Bessemer and open-hearth processes, and the other method is to take wrought iron and add carbon to it, as in the cementation and crucible processes.

The Bessemer Process.

In the Bessemer process the molten pig iron is put into a large pear-shaped vessel, called the converter, the bottom of which is double, the inner one being perforated with numerous holes, called tuyeres, to admit air to be forced in under pressure. The molten iron (from 10 to 15 tons at a time) is poured into the converter while the latter is lying on its side, then the compressed air is turned into the double bottom as the converter rises to a vertical position. The air has sufficient pressure (about 20 pounds per square inch) to prevent the molten metal from entering the tuyeres. The air streams pass up through the molten metal (piercing it like so many needles), burning out the carbon, silicon, etc., accompanied by a brilliant display of sparks and a flame shooting out of the mouth of the converter. The 15 tons of molten pig iron contain nearly ¾ of a ton of carbon, and since this carbon is all burned out in less than ten minutes, this rapid rate of combustion increases the heat of the metal very much; it does not cool it, as one would suppose at first thought. The flame, therefore, at first red, becomes brighter and brighter, until it is finally so white that it can scarcely be looked at with the naked eye. A "blow" generally lasts about nine to ten minutes, when the sudden dropping of the flame gives notice that the carbon is all burned out. The metal in the converter is then practically liquid wrought iron, the converter is then laid on its side again, the blast shut off and a certain amount of spiegeleisen or ferromanganese is added in a liquid form so as to give the steel the proper amount of carbon and manganese to make it suitable for the purpose desired. The liquid steel is then poured out into so-called "ingot molds," and the resulting "ingots," while still hot, but no longer liquid, are rolled out into blooms, billets, or rails without any additional reheating except a short sojourn in so-called "soaking pits." In some steel works, where the molten pig iron is taken in large ladle cars direct from the blast furnace to the converter, it is possible to produce rails without adding any fuel to that contained in the molten pig iron, so that the red-hot rail just finished still contains some of the heat given it by the coke in the blast furnace.

The Open-hearth Process.

The open-hearth process, sometimes called "the Siemens-Martin process," is similar to the puddling process, but on a much larger scale. The furnaces generally have a capacity of from 40 to 50 tons of molten metal (in some exceptional cases as high as 200 tons); they are heated by gas made from bituminous coal (oil and natural gas have also been used). The gas and the air needed for its combustion are heated to a high temperature (over 1,000 degrees) before entering the combustion chamber, by passing them through so-called regenerative chambers. Owing to this preheating of the gas and the air, a very high temperature can be maintained in the furnace, so as to keep the iron liquid even after it has parted with its carbon. The stirring up of the molten metal is not done by hooks as in the puddling furnace, but by adding to the charge a certain proportion of ore, iron scale, or other oxides, the chemical reaction of which

* Article by George Schuhmann, General Manager Reading Iron Company, published in *The Pilot*, official organ of the Philadelphia and Reading Railway Department Y. M. C. A., Reading, Pa.

keeps the molten iron in a state of agitation. While in the Bessemer process only pig iron is used, in the open-hearth furnace it is practicable to use also scrap of wrought iron or steel, as the high temperature in the furnace will readily melt it. When the pig iron or scrap contains too much phosphorus, burnt lime is added to the charge; the resulting slag will absorb the phosphorus, thus taking it out of the metal. This dephosphorization by means of burnt lime is called the basic process in contradistinction to the acid process, where no lime is used, but where care must be taken that the metal charged is low in phosphorus. In this country, the basic process is at present used only in connection with open-hearth furnaces, while in Europe it is also used in many Bessemer plants producing the so-called "basic Bessemer steel."

Producing Tool Steel.

Crucible steel or tool steel, formerly called cast steel, is made by using high grade, low phosphorus wrought iron and adding carbon to it. The oldest method is the so-called "cementation process" in which the iron bars are packed in air-tight retorts, with powdered charcoal between the bars. The filled retorts are put into a cementation furnace, where they are heated to a red heat and kept at that temperature for several days, during which time the iron will absorb about 1½ per cent of its own weight of carbon. The process is similar to the case-hardening process familiar to many blacksmiths. The carbonized bars, called "blister steel," are then cut into small pieces, remelted in a crucible, and from there poured into molds, forming small billets, which are afterward hammered or rolled into the desired shapes. The newer method is to put the small pieces of wrought iron direct into an air-tight crucible mixed with the proper amount of powdered charcoal, and melt down; the iron will absorb the carbon much quicker while in a molten state than when only red-hot, as in the cementation furnace. The other ingredients, such as chrome, tungsten, etc., are also added in the crucible.

Malleable and Steel Castings.

Malleable castings are produced in the reverse way from the blister steel referred to above, that is, instead of taking wrought iron and adding carbon, castings made of cast iron are made malleable by extracting the carbon. The castings are packed into retorts similar to the cementation retorts, but, instead of charcoal, an oxide of iron, generally in the shape of hematite ore, is packed with them, and kept in a red-hot state for several days. The oxygen of the ore will absorb the carbon in the iron, giving the latter a somewhat steely nature.

Steel castings used to be produced in the same manner, but now, steel castings are cast direct from the ladle containing molten steel, which is generally melted in an open-hearth furnace, although small Bessemer converters are also sometimes used for this purpose.

Comparison between Wrought Iron and Low Carbon Steel.

While chemically there is not much difference between wrought iron and low carbon steel, there is considerable difference in their physical structures. Owing to the globules of pure iron being coated with cinder in the puddling furnace, the subsequent rolling and reworking while expelling a large portion of this cinder always leaves traces of it behind which gives wrought iron the fiber. Steel having been produced in a liquid form, where the cinder all floated to the top and was removed, the metal is homogeneous, that is, without any grain or fiber. When subjected to many vibrations, or strains due to frequent expansion and contraction, wrought iron will generally yield gradually and give warning to the inspector, while steel is more liable to snap off suddenly. Wrought iron being composed of many fibers, the fibers can break one at a time without directly affecting its neighbor (like the strings in a rope), while a rupture once started in steel will extend more rapidly. Wrought iron will also resist corrosion and pitting longer than steel, no doubt due to higher resisting power of the enclosed cinder, which also causes the acid to deflect endwise, thus weakening its action by diffusing it over a larger area and preventing deep pitting. Stay bolts and boiler tubes for locomotives have proved more satisfactory when made of charcoal iron than of steel. Thin sheets, tin plate, corrugated iron covering, wire fencing, pipes, oil well casings, etc., have also proved much more durable when made of wrought iron than when made of steel. On the other hand, in rails, tires, guns, armor plate, etc., steel has proved far superior to iron, owing to its greater strength and hardness, and where corrosion is of minor importance, owing to the rails, etc., generally being worn out long before corrosion has a chance to affect them seriously. When structural steel or iron is used for bridges, etc., it is necessary to protect the metal from serious corrosion by frequent and careful painting, and in the skeletons of high office buildings and other skyscrapers, when completely covered with concrete, etc., so as to thoroughly exclude air or moisture, steel as well as iron will last indefinitely.

Where material is buried in the ground, or exposed to the weather without the careful protection of paint, or where moisture has access to it by other channels, as in the interior of pipes, for instance, wrought iron will outlast steel by a good margin.

* * *

THE HUMAN FRAME AS A POWER PRODUCER.

One of the great problems of the age is the utilization of convict labor in a manner that shall not conflict with the best interests of free labor. From an economical standpoint it is not profitable to any community that its criminals be either idle or engaged on work which is of no material use. Without discussing the ethical and economic features of prison labor further, we may say that about the most ridiculous scheme that we have seen proposed is that of a correspondent of the *American Shipbuilder*, who suggested that convicts be employed to work treadmills to charge storage batteries with which to propel the East River ferry-boats of New York City. It is still further proposed that if the plan were successful, the convicts all over the State be employed in tread-mills for generating electricity for lighting and heating their prison buildings. The correspondent did not mention that the same tread-mills could be used for electrocuting the criminals who suffer capital punishment, but this is a detail which he probably forgot. The author probably did not realize that the human frame as a machine for producing power is of very small effect. The average work done by a man raising his own weight on a stair, ladder or tread-mill is only about 2,000,000 foot-pounds per working day of ten hours, or 1-10 horse-power. Thus, 500 convicts working in a tread-mill would produce only 50 horse-power, and that only for ten hours per day. It does not require a great deal of engineering ability to discover that such a scheme would be practically valueless, being equivalent to saving only 1,500 pounds of coal on the basis of 3 pounds per horse-power hour.

* * *

The daily press reports that the Baldwin Locomotive Works has built a locomotive to the metric system of measurements, and that this feat is a signal triumph for the friends of that system. According to the report, it has always been the favorite assertion of its opponents that the metric system would result in endless confusion where the entire organization of shops and training of men were based on the English system of measurements, but here is a case where the largest locomotive works has built an entire locomotive to the metric system without difficulty. This result really signifies very little, of course. If need be, the locomotive could have been built to the Chinese "fan" or the sailor's knot, or to any other system, with as good success. The item further states that the building of the locomotive necessitated the introduction of many new standards and gages. Now, this is the kernel in the nutshell, and is just the point that the supporters of the metric system minimize. No one doubts but that the metric system can be used in our shops, but its adoption means a very large cost for new gages and tools, and the conversion of English measurements, tables, data, etc., into the metric system. It would take many years for such changes to be effected, for in many cases it would, of necessity, be done gradually, and it is quite doubtful in the minds of those who have opportunity to use both systems that the resulting advantages would be worth a small fraction of the cost of the change.

ON THE ART OF CUTTING METALS.—8.*

FRED. W. TAYLOR.

EFFECT OF FEED AND DEPTH OF CUT ON CUTTING SPEED.

The following are the principal conclusions arrived at on the effect of varying the feed and the depth of the cut upon the cutting speed.

A. With any given depth of cut, metal can be removed faster, *i. e.*, more work can be done, by using the combination of a coarse feed with its accompanying slower speed than by using a fine feed with its accompanying higher speed.

For example, if with a combination of 3/16 inch depth of cut and 1/64 inch feed, the hardness of the metal were of such a quality, for instance, that just 100 pounds of chips would be cut off in an hour, by using the same tool on the same forging at its proper cutting speed corresponding to a feed of ⅛ inch, the metal would then be removed at the rate of 250 pounds per hour. In most cases it is not practicable for the operator to take the coarsest feeds, owing either to the lack of pulling power of the machine or the elasticity of the work. Therefore, the above rule is only, of course, a broad general statement.

B. The cutting speed is affected more by the thickness of the shaving than by the depth of the cut. A change in the thickness of the shaving has about three times as much effect

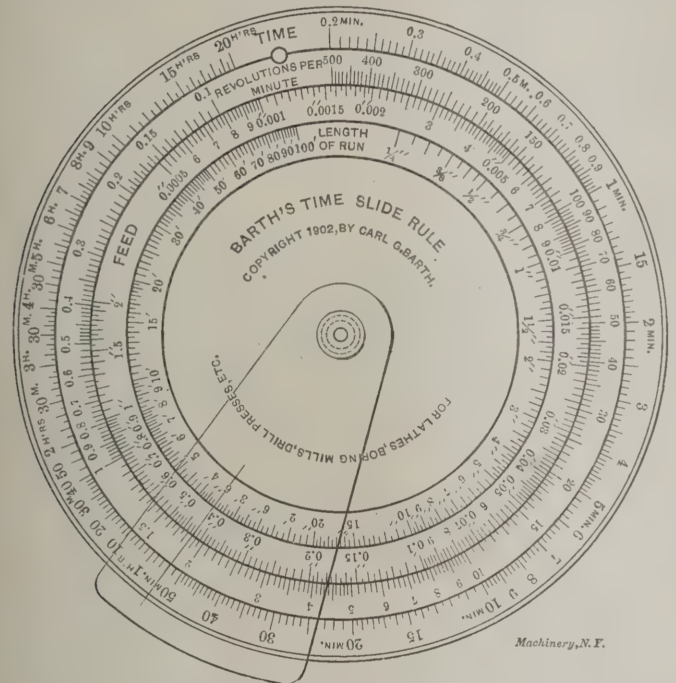


Fig. 48. Barth's Time Slide Rule for Machine Shops, used in Connection with Lathe Slide Rule shown in Fig. 49.

on the cutting speed as a similar or proportional change in the depth of the cut has upon the cutting speed. Dividing the thickness of the shaving by 3 increases the cutting speed 1.8 times, while dividing the length that the shaving bears on the cutting edge by 3 inceases the cutting speed 1.27 times.

C. Expressed in mathematical terms, the cutting speed varies with our standard round-nosed tool approximately in inverse proportion to the square root of the thickness of the shaving or of the feed; *i. e.*, S varies with $\sqrt{F}$, approximately.

D. With the best modern high-speed tools, varying the feed and the depth of the cut causes the cutting speed to vary in practically the same ratio whether soft or hard metals are being cut.

E. The same general formula expresses the laws for the effect of depth of cut and feed upon the speed, the constants only requiring to be changed. This is a matter of very great importance, as it enables us to use a single slide rule as a means of finding the proper combination of speed and depth of cut and feed for all qualities of metal which may be cut.

F. The same general type of formula expresses the laws governing the effect of the feed and depth of cut upon the cutting speed when using our different sized standard tools. This is also fortunate as it simplifies mathematical work in the final solution of the speed problem.

Importance of the Study of Effect of Feed and Depth of Cut upon Cutting Speed.

A study of the effect of the feed and depth of cut upon the cutting speed constitutes, in our judgment, the most important element in the art of cutting metals. As pointed out in the opening paragraphs of this paper (see MACHINERY, January issue) the three questions which must be answered each day in every machine shop by every machinist who is running a metal cutting machine, such as a lathe, planer, etc., are:

What tool shall I use?
What cutting speed shall I use?
What feed shall I use?

Having already established in a shop standards for the shape and quality of the tools, there remain but two of these questions to be answered, namely, as to the cutting speed and the feed. And the decision as to the cutting speed will depend more upon the depth of cut and feed which are chosen than upon any other element.

Tables Giving Cutting Speeds Corresponding to Different Depths of Cut and Thickness of Feed.

In the data sheet are practical working tables which will be found useful by machine shop foremen and machinists as a general guide to determining what cutting speed to use under several of the usual or typical conditions met with in ordinary machine shop practice. The cutting speeds given in these tables are based upon the use of our standard tools for cutting as well hard steel and cast iron as for cutting medium and soft steel. In making these tables we also assumed the use of the best quality of high-speed tool treated in the best manner. The tables were also based upon cutting three different qualities of steel, and the following cutting speeds when cut with our standard ⅞-inch tool, 3/16 x 1/16, for standard 20-minute cut.

Hard steel: cutting speed, 45 feet per minute, such for instance as is used in a hard locomotive tire.

Medium steel: cutting speed, 99 feet per minute.

Soft steel: cutting speed, 108 feet per minute.

The tables made out for cutting cast iron are based upon three qualities of cast iron which we have found representative of hard, medium and soft cast iron as ordinarily found in the average machine shop in this country. In each shop, however, accurate experiments should be made to determine the average cutting speeds of the cast iron actually used.

Best Guide to Hardness as it Affects Cutting Speeds Lies in the Physical Properties of Steel.

The physical properties of steel constitute a fairly accurate guide to its cutting speed; and these properties are best indicated by the tensile strength and percentage of stretch and contraction of area obtained from standard tensile test bars cut from such a position in the body of the forging as to represent its average quality, and then broken in a testing machine.

It is, of course, impossible in most cases for any ordinary machine shop to cut test bars from the forgings which are actually used in the shop. It is, however, entirely possible, and in many cases desirable, to purchase forgings and castings with certain guaranteed tensile strength, stretch and contraction, and thus insure both the superior quality of the metal bought, and at the same time obtain metal practically uniform in its cutting speed. In our search for a guide to the cutting speed of metals, this has proved the only reliable index to the cutting speed.

We have developed the following empirical formula which is at least a partial guide to the cutting speed of steel of good quality when the physical properties of the forging are known as represented by a standard test bar 2 x ½ inch, cut from the body of the forging, and broken in a testing machine.

$$V = \frac{125\left(1 - \dfrac{215}{(15+E)^2}\right)}{\sqrt{\dfrac{S}{10000} - 3} - 0.9}$$

in which V = standard cutting speed;
S = tensile strength in pounds per square inch;
E = percentage of elongation of specimen 2 inches by ½ inch.

Effect of the Quality or Hardness of the Cast Iron upon the Cutting Speed.

It is much more difficult to predict the correct cutting speed for cast iron than for steel, and as yet no reliable method for doing this has come to our attention.

* Abstract of paper read before the American Society of Mechanical Engineers, December, 1906.

Viewed from the standpoint of chemical analysis, the cutting speed becomes slower the larger the amount of combined or cement carbon contained in the casting, and the cutting speed becomes less the smaller the amount of silicon contained in the casting. The amount of combined carbon, however, depends largely upon the rate or rapidity with which the cast iron has been cooled after being poured into the mold; so that the mixture of the metal in the cupola does not constitute an accurate guide to the hardness of castings.

In cutting almost all qualities of cast iron, the wear on the tool is due to two causes:

a. The abrasive or grinding action of the carbon or gritty matter contained in the body of the iron itself; and

b. the heat generated by the pressure of the chip upon the tool.

In resisting the second of these causes for injury to the tools (*b*), the quality of red hardness tends greatly to increase the cutting speed. However, there is no doubt that the first of the two causes (*a*) plays much the more important part in injuring tools which are cutting cast iron, and in resisting this abrasive action the quality of red hardness is of but little use. For the same reason also, in cutting sand on the outside of castings or a mixture of sand and iron, the high speed tools are but little better than the old-fashioned self-hardening tools.

Cutting Speed on Castings as Found in the Average Machine Shop.

As a broad general guide to the cutting speeds to be used for cast iron with the scale on the castings just as they come from the foundry, we would state that as the average of several machine shops in this country, it is our observation that a 3/16 inch depth of cut and 1/16 inch feed, has a cutting speed of 60 feet per minute.

Effect of Scale on Cast Iron Castings upon the Cutting Speed.

As to the effect of the average scale met with in castings in the average shop, our experience indicates that with very soft castings the average scale met with calls for a cutting speed only about one-half as fast as the cutting speed of the same casting below the scale, and that as the castings grow harder and harder, the cutting speed of the scale approaches that of the cast iron below the scale, so that with the castings referred to as "hard" castings, the cutting speed of the scale and of the metal below the scale is about the same. On medium castings, the cutting speed of the scale may be said to be, in general, about three-fourths as fast as the cutting speed below the metal of the scale.

Cutting Speeds of Parting Tools and Thread Tools.

By a "parting tool" we mean a narrow, square-nosed tool which is fed directly "end on" into the work, for the purpose of cutting it or slicing it into two pieces. The two corners of the parting tools experimented with were rounded to the extent of about 1/64 of an inch.

By a "thread tool" we mean the ordinary tool for cutting the United States Standard V Threads, having a 60 degree included angle. The extreme point of this thread tool was also squared off to the extent of about 1/64 of an inch.

The ratio of a thread tool to a tool with a straight line cutting edge under the same conditions, that is, when both were fed with the same feed, "end on," straight into the work, was found by two experiments to be as 0.45 : 1.

The practical problem, however, for the man who is running a machine shop, is to find quickly, when he has a given quality of metal, at just what speed he must run his parting tool or his thread tool to do the work with the greatest economy; and we would suggest the following as a practical rule for obtaining the desired cutting speed.

Referring to the data sheet tables for cutting steel and cast iron, find first the feed, *i. e.*, the thickness of the chip which is to be cut by the parting tool; then look in the table for cutting steel or cast iron as the case may be, for our standard ⅞-inch tool under 3/16-depth of cut and with the thickness of the feed which corresponds most nearly to the given thickness of the chip which is to be taken by the parting tool; read off the cutting speed from this table, and divide it by 2.7, and this will give the proper cutting speed for the parting tool.

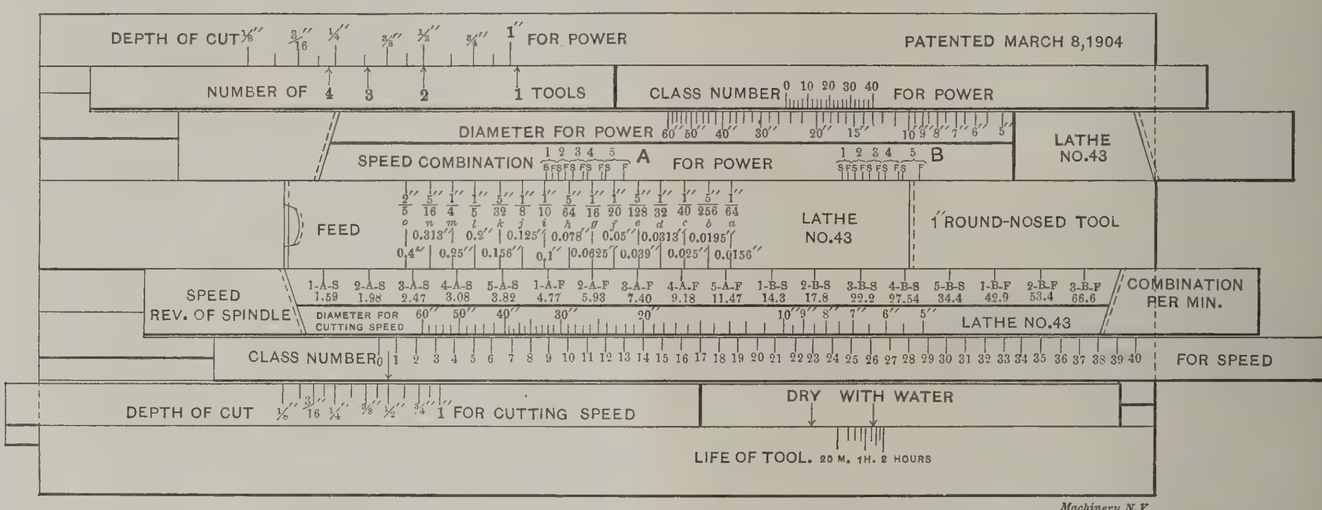


Fig. 49. Lathe Slide Rule embodying the Twelve Important Laws Deduced as the Result of Twenty-six Years' Investigation.

In other words, if we take the practical economical cutting speed of our ⅞-inch standard round nosed tool when using 3/16 inch depth of cut and a feed which is the same as the thickness of chip to be cut by the parting tool, the speed of our standard tool under these conditions will be 2.7 times as fast as the proper speed for the parting tool.

If in the same way we first determine the thickness of the chip over the point or extreme nose of the thread tool, *i. e.*, if we determine the exact advance of the thread tool toward the center line of the work each time a cut is taken, and call this advance the thickness of the chip; and if we then proceed as described just above in the case of the parting tool, it will be necessary to divide the speed obtained for our standard round-nosed tool by 4. Or, in other words, if we take the practical economical cutting speed of our ⅞-inch standard round-nosed tool when using a 3/16 inch depth of cut and a feed which is the same as the advance of the thread tool toward the center line of the forging which is made after each cut taken by the thread tool, the speed of our standard tool under these conditions will be four times as fast as the speed of the thread tool.

* * *

A syndicate is flooding the country newspapers with direful accounts of the failure of municipal ownership of public utilities. It is quite affecting to see how considerate certain people are of others' welfare, and to note their strenuous efforts to keep cities and towns from dabbling in that which will burn their fingers. One cannot help thinking, however, that there may be something of selfish interest in it all. Unfortunately for the spread of municipal ownership there are no subsidized press agents to sing its praise.

PERSPECTIVE AND ISOMETRIC DRAWING.*

FREDERIC R. HONEY.†

In my last contribution to MACHINERY, January 1907, I referred to isometric projection as one of the means of representing an object pictorially, that is, to give to the ordinary observer a clearer idea of its form than that which is conveyed by its plan and elevation. For this reason this method has sometimes been described as "isometric perspective"—an

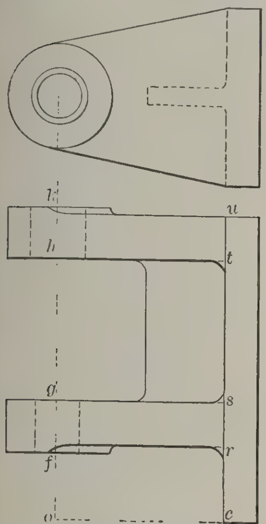


Fig 1. Bracket shown in Orthographic Projection.

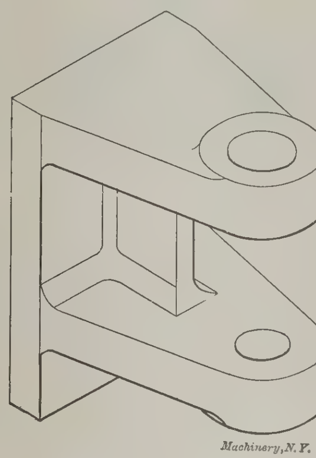


Fig. 2. Same Bracket shown in Isometric Drawing.

erroneous expression, because perspective and isometric drawing are distinctly different methods of representation. A perspective drawing, correctly constructed, presents to the observer from a given point of sight the same apparent outline as that of the object itself, while an isometric projection is a distorted representation. This distortion increases with the increase of the dimensions of the object, and may convey an inaccurate idea of its real form and proportions.

The object selected here to illustrate these different methods is shown in Fig. 1, in which, in reduced scale, are two views of a casting for carrying the worm which operates the turning gear of a triple-expansion engine, the dimensions of which are taken from "Machine Drawing and Design" by Low and Bevis. In Fig. 1 the piece is shown in the position it occupies when bolted to the frame of the engine, *i.e.*, the axis of the worm is vertical. Fig. 2 is an isometric drawing of Fig. 1. The principal axes form angles of 120 degrees with each other, and real measurements are laid off upon them. It would not be correct to call this an isometric projection, because certain dimensions should be diminished to a little over four-fifths of their true length. The precise length of the isometric scale is shown in Fig. 5, which is constructed as follows: Draw the 45-degree line $a\,b$ equal to the length of an ordinary scale, we will say 12 inches; from one end draw the 30-degree line $a\,c$ and draw the perpendicular $b\,d$ intersecting $a\,c$ at c. The line $a\,c$ is the true length of the isometric scale of 12 inches, which may now be divided into inches and parts. The length of $a\,c$ may be computed as follows: Multiply 12 inches by the cosine of 45 degrees and we obtain the length of $a\,d$. If $a\,d$ be multiplied by the secant of 30 degrees we have the length of $a\,c$. Thus, $12 \times \cos 45° \times \sec 30° = 12 \times 0.7071 \times 1.1547 = 9.798 =$ 9 4/5 inches.

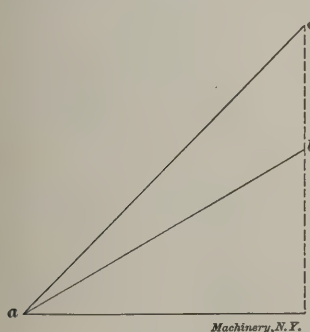


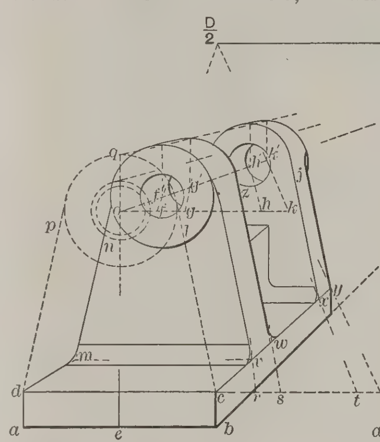
Fig. 3.

Fig. 2 is therefore the projection of a figure whose dimensions are greater than those shown in Fig. 1. But all the dimensions are shown in their natural length, and thus the figure is drawn at once, avoiding the change from the ordinary to the isometric scale. This system has the advantage also of representing in their true value the principal dimensions of the object, *i.e.*, those dimensions that are parallel to the coordinate axes.

It should be noted that the major axis of the ellipse which represents a circle, should be longer than that which is laid off when the isometric scale is employed. Its length is easily found as follows: Lay off the true length of the diameter of the circle on the 30-degree line $a\,b$, Fig. 3, and the perpendicular from b will intersect the 45-degree line $a\,c$ at c. The line $a\,c$ is the required length. The circles are treated in this way in Fig. 2, which may be described as an "isometric drawing" as distinguished from an isometric projection of Fig. 1.

Whenever it is necessary to represent circles in this kind of projection, the drawing of ellipses is unavoidable in whatever position the object is placed. Since it is desirable to avoid these constructions whenever possible, the draftsman should make a perspective drawing of the object in the position, Fig. 4, in which the circles are parallel to the plane of the paper, and are easily drawn in perspective, because in each case the perspective of the circle is a circle. In this position is obtained a view of the object that satisfies the eye. When it is at the right distance from the drawing, the apparent outline is precisely the same as that which would be observed if the object itself were placed before the draftsman. Therefore it is obvious that this mode of representation is preferable to the isometric drawing.

In Fig. 4 the lower end of the casting is turned toward the observer, and the rectangle $a\,b\,c\,d$ is shown in its true dimensions. The center line $e\,o$, drawn perpendicular to $a\,b$ at its



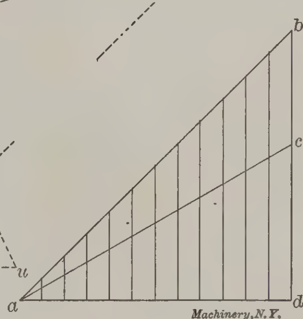


Fig. 4. Perspective Drawing of Bracket. Fig. 5.

middle point, is made equal to the corresponding measurement in Fig. 1. The horizon is drawn at any assumed distance above the object, and the distance from S to $\frac{D}{2}$ measures one-half the distance from the eye of the observer to the paper. From o, the center of the circles, draw a line to S and a horizontal line. On the latter lay off $o\,f$, $o\,g$, $o\,h$ and $o\,k$ equal respectively to one-half of $o\,f$, $o\,g$, $o\,h$ and $o\,k$ in Fig. 1, *i. e.*, in each case one-half of the distance between the center of the circle and the plane containing the rectangle $a\,b\,c\,d$.

From f, g, h, and k, draw lines to $\frac{D}{2}$ intersecting $o\,S$ at f', g', h' and k', the centers of the perspective circles whose radii are determined by drawing a line from q to S intersecting perpendiculars from these centers. From these centers describe the four circles, two of which will be limited by tangents which are drawn as follows: Produce the line $d\,c$ and lay off $c\,r$, $c\,s$, $c\,t$ and $c\,u$ respectively equal to one-half of $c\,r$, $c\,s$, $c\,t$ and $c\,u$ in Fig. 1. From r, s, t and u, draw lines to $\frac{D}{2}$ intersecting $c\,S$ at v, w, x and y. From w and x draw the parallel tangents $w\,z$ and $x\,j$, and from v and y draw parallels to these tangents. These lines are also parallel to $c\,l$. With the aid of the drawing the draftsman will easily complete the perspective.

It should be noted that the smaller circles are constructed

*The following articles regarding perspective and oblique projections have previously been published in MACHINERY: Notes on Isometric Perspective, October, 1904; The Practical Perspective, September, 1904; Perspective vs. Oblique Projections, January, 1907.
†Instructor, Trinity College, Hartford, Conn.

in the same manner as those already described, and the line $m\,n$ is drawn parallel to $d\,p$. To avoid confusion, invisible lines are omitted, but these may be added after erasing the construction lines. To make a perspective drawing rapidly, the object should be placed in a position which makes it easy to draw the lines with a minimum of mechanical work. The foregoing is selected partly to illustrate this point. Circles are represented by circles, and all those lines that are parallel to the plane of the paper are represented by parallel lines.

In isometric drawing, the larger the dimensions of the object, the more marked is the distortion. In perspective drawing, the eye is perfectly satisfied with the form because it correctly represents the apparent relative positions of every point and line.

* * *

SIMPKINS AND HIS HAND-BAG.

M. E. CANEK.

Simpkins was a mechanic—a tool-maker if you please. His wife bought a small hand-bag to carry his lunch down to Berg's big machine shop, across the river—it looks so much more genteel that way, you know. That night Simpkins looked the bag over, tried its weight, and filled it with

"Learned that down in Baxter Street, New York."

some odd junk to see how it carried. The catch did not hold; when the bag was full it had a very disagreeable and startling way of opening and showing the contents to all beholders. Certainly, it would never do to have his lunch displayed to the sneering passers-by when walking down Main Street. Simpkins looked at the catch with a mechanic's eye. He wanted to use the bag the next day, but did not like the job of fixing it. Bag-makers have such a foolish way of fastening everything with rivets and "turn-overs," which break off when you try to straighten them out. So he gave it up, and carried his dinner in the old lunch-box, taking along the bag to exchange it for another on his way down town.

"Say, Jones, that bag you sold my wife is N. G. Catch won't hold."

"Don't hold, eh. Let's see it. Humph! I'll fix that in a shake of a lamb's tail."

Suiting the action to the word, Jones, who hardly knew a hand-saw from a monkey-wrench, seized an old pair of pliers that lay on the counter and gave the two dinky little hooks a slight twist around to starboard, and lo! the job was done.

"Learned that down on Baxter Street, New York," said Jones, beaming on poor Simpkins as he handed the bag over the counter.

"Good scheme," said Simpkins weakly, and walked out, thinking as he went: "Even if you are a tool-maker, handling a micrometer is not everything in the mechanic's trade. There are lots of tricks that you don't know yet."

OIL ENGINES.*

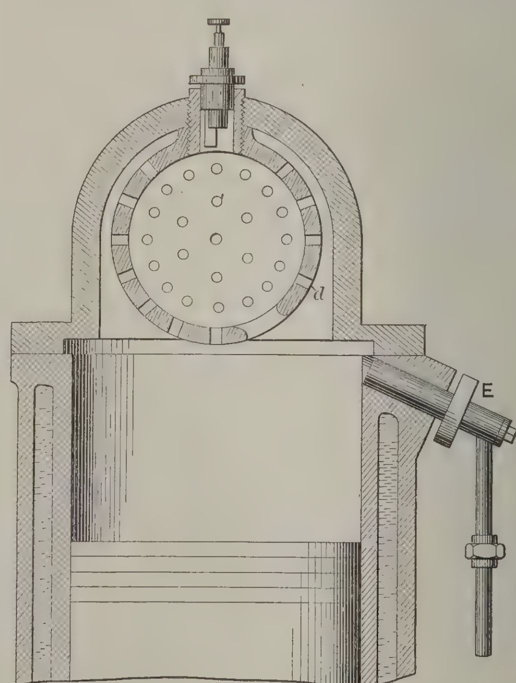
S. M. HOWELL.†

S. M. Howell.‡

The production of power by the combustion of crude mineral oil in the cylinder of a gas engine is a problem which has been persistently followed by many inventors; and to a great extent their efforts in this direction have been successful. This is true at least as regards stationary engines in certain situations, where the use of oil fuel is convenient or desirable on account of local conditions, such as proximity to the great oil fields, or in isolated places not supplied with gas, and in buildings which would be endangered by the presence of gasoline or other highly inflammable liquids. But there is also another field for the oil engine whenever it can be made to meet the requirements. The well-known gasoline engine has heretofore been relied upon exclusively in this country as the motor for small boats, automobiles and other self-propelled vehicles; but the growing scarcity of gasoline has made its more limited use for this purpose a matter of economy, if not a measure of necessity. Herein is the opportunity for the oil engine. An automobile, however, requires a motor of great flexibility and ease of control under wide variations of speed and load, and the use of oil engines in this way has only recently been attempted.

No Essential Difference in Operative Principles of Internal Combustion Motors Using Oil and Gasoline.

As regards operative principles there is no essential difference between an oil engine and an engine made to use gasoline, but there is an important difference in the character and properties of the respective liquids, and the difficulties en-



Machinery, N.Y.

Fig. 1. G. A. Phail Kerosene Engine, Pat. No. 743,097, Nov. 3, 1903.

countered in the design of a successful oil engine exist in the nature of the fuel. Mineral oil in its crude state is in reality a complex combination of various liquid and solid

* The following articles regarding oil engines and kindred subjects have previously been published in MACHINERY: The Oil Engine, September, 1898; The Commercial Advantage of the Oil Engine, June, 1899. An Interesting Engine, May, 1899; Patents in their Relation to the Gas Engine and the Automobile, January, March, and May, 1906 (engineering edition).

† Address: 103 Flag St., Zanesville, Ohio.

‡ S. M. Howell learned the machinists' trade and art of mechanical drawing at the Baldwin Locomotive Works and Spring Garden Institute at Philadelphia, Pa., in the years from 1889 to 1893. His present occupation is largely the designing of engines and special machinery, and the mechanical development of patents. He has had a wide range of experience, having been employed by a number of prominent machine-building concerns.

hydrocarbons, and these constituents vary greatly in their relative proportions to each other in the several grades and qualities of oil as found in different localities. But for practical purposes in the present instance we may say that crude oil is in general a mixture of either asphaltum or paraffine with kerosene and gasoline. These substances when separated by distillation form the commercial products of the oil refinery. Crude oil is, of course, cheaper than the refined product, and is in many localities abundantly available; but the refined article known as kerosene is in such well-established use as to have become a staple article of retail commerce in all parts of the world, and may readily be procured at all times in any locality. Its cost per gallon is considerably less than that of gasoline, and its fuel value is higher. Its comparative cost per unit of fuel value probably does not now exceed one-half that of gasoline, and this difference bids fair to grow wider.

It should be remembered, however, that kerosene is not so rapidly inflammable as gasoline or alcohol, requiring a little more time for its combustion. Therefore a kerosene engine will not run at the high speeds now used in automobile practice with gasoline. Kerosene, moreover, requires heat for its vaporization. Heated air having a temperature of about 500 deg. F., drawn through a carbureter supplied with kerosene, will absorb the liquid and form an explosive mixture, there being several oil engines now on the market operating in this way, and in a few cases said to be driving automobiles. In

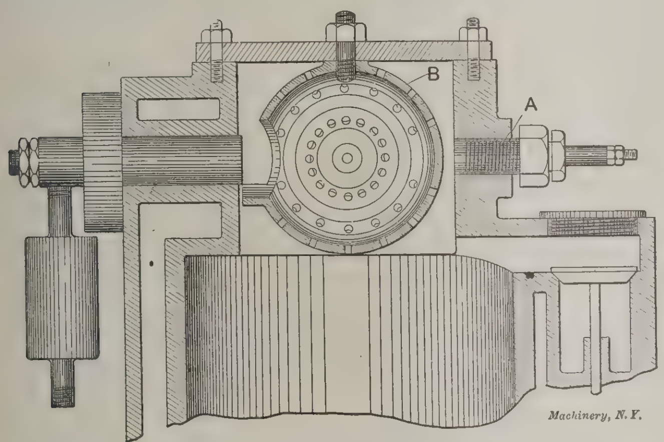


Fig. 2. N. L. and W. W. Tuck Vaporizer and Igniter for Oil Engines. Pat. No. 762,960, June 21, 1904.

order, however, that the engine may be started, an auxiliary device, consisting of a small closed vessel containing gasoline, must be used. This is connected with the vaporizer and arranged in such a way that when the engine has been started and run for a few minutes, the gasoline may be switched off and the oil instantly turned on by the motion of a lever. Only a small quantity of gasoline is required for this, merely a few spoonfuls being used at each time of starting. A few revolutions of the engine on gasoline will heat the vaporizer sufficiently to make the oil fuel at once available. The air receives its heat from the exhaust, and becomes hot before coming in contact with the oil in the carbureter. This is a practical and easy method of using kerosene in a gas engine, and is quite reliable. In the case of an automobile engine, the gasoline auxiliary may be quite small and compact, containing say a quart or two of the liquid, which should suffice for starting purposes for several days.

Internal Vaporizer Type Engines.

Another style of oil engines is that known as the internal vaporizer type. In these engines no outside heating device for the air is required, but the gasoline auxiliary just described, or some equivalent means of preliminary heating, must usually be employed. In these engines the oil is injected into the cylinder as the air enters, or in some cases during the return or compression stroke of the piston, in the latter case being sprayed in by a small stream of air under pressure. By this means the oil is atomized and enters the cylinder in the form of a mist which strikes the heated head or some part of the internal surface, and is thereby still further reduced or completely vaporized and mixed with the air. To this class belong the following engine types.

The Phail Kerosene Engine.

Fig. 1 shows the vaporizing device of the Phail engine, consisting of a hollow cast iron ball within a dome-shaped projection of the cylinder or its head. This ball is perforated with numerous small holes, and also has a larger opening shown near the bottom through which the oil reaches the interior of the ball, injected by a small pump at E. The oil is forced in

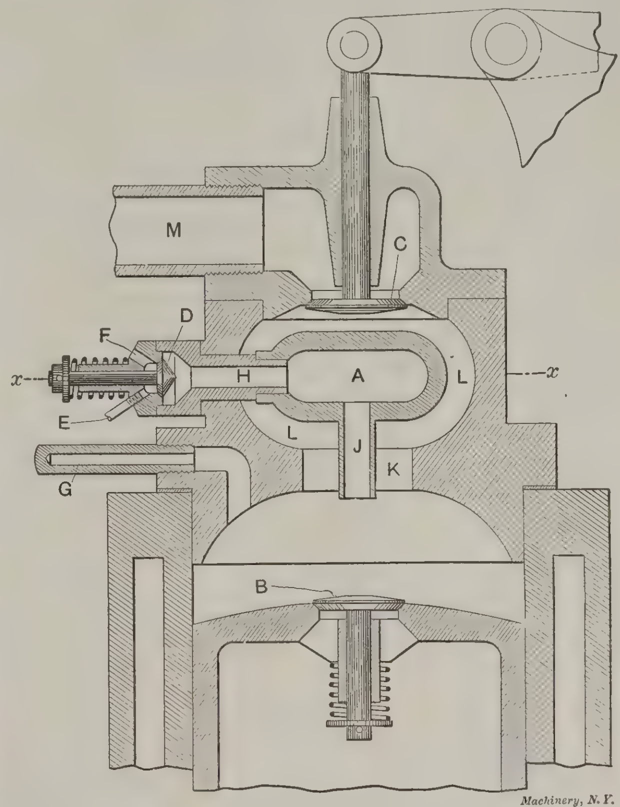
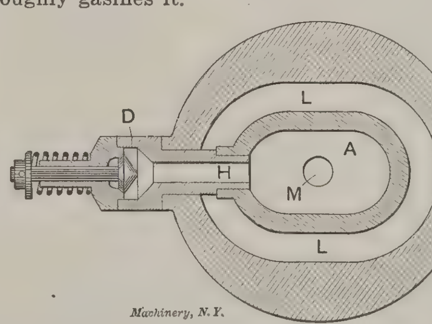


Fig. 3. V. V. Torbensen Oil Engine, Pat. No. 653,854, July 17, 1900.

during each compression stroke of the engine piston, and the ball is kept at a high temperature by the heat of the explosions. The engine is of the two-cycle type, the air being received at the beginning of each compression stroke through a port not shown in the drawing. The exhaust takes place in a similar manner through another piston-operated port opposite the air-inlet as usual in two-cycle engines. The compression stroke of the piston drives the air through the small holes into the red-hot ball, where it meets the entering spray of oil and thoroughly gasifies it.



SECTION x—x

Fig. 4. Section in x—x of Oil Engine in Fig. 3.

This patent is somewhat remarkable for its brevity, and the restricted nature of its claims. These are three in number, and each is limited by the inclusion of an electric igniter within the hollow ball. Therefore, if the igniter was placed outside the ball or the ignition was effected by other means than that of the electric spark, such a device would not come within the limitations of the patent. The engine is, however, regularly manufactured by a large firm, and is extensively used for stationary power in small units. It is highly efficient, and will vaporize and consume kerosene completely.

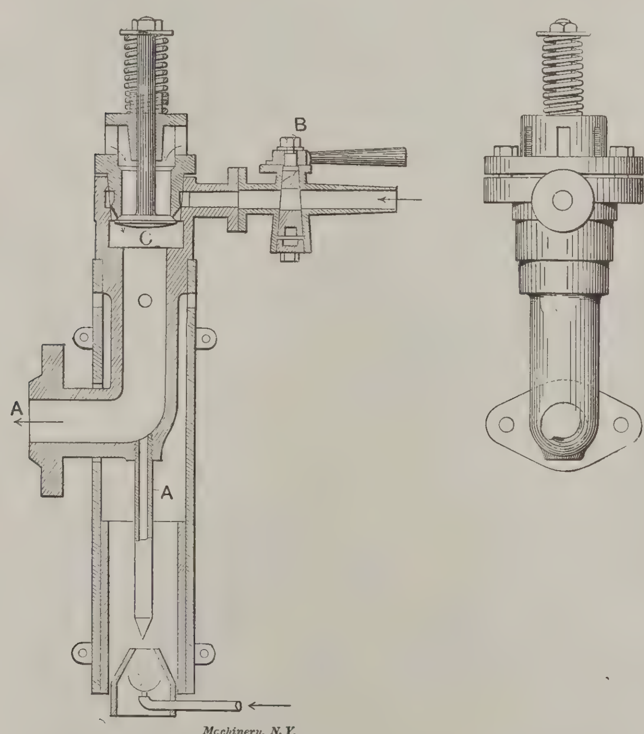
The Tuck Engine.

Another similar construction is the Tuck patent, shown in Fig. 2. In this patent the electric igniter A is outside of the

perforated ball vaporizer *B*, and the inventor states that after the engine has been started, electric ignition is dispensed with, the charge being fired automatically by the heat of the vaporizer. This method of ignition is very commonly used also in many other engines of this class.

The Torbensen Engine.

The Torbensen patent illustration is shown in Figs. 3 and 4, in which *A* is the familiar internal vaporizer. *B* is the air admission valve located in the piston, which opens and closes automatically by the preliminary compression of the air in the crank-case. *C* is the exhaust valve, and *D* the oil admission valve. The oil enters through pipe *E*. *F* is an opening to the atmosphere. This opening also leads to, and is controlled by, the oil admission valve *D*. *G* is the ignition tube, which is used only for starting. This tube is first heated by a torch in order to ignite the first few charges, after which the torch is removed and ignition effected automatically by the heat of the vaporizer. The out-stroke of the piston draws open the oil admission valve, and also the air admission valve *B;* the oil enters and passes the valve *D* in company with a small stream of air entering at *F*. The air takes up the oil and carries it as fine spray through the passage *H* to the vaporizer *A*, and thence through the tube *J* to the interior of the cylinder, where it meets a much larger volume of air entering by the valve *B* in the piston. The atomized oil having been thus highly heated by its passage is now thoroughly mixed with the main body of the air charge, and exploded at the termination of the compression stroke by contact with the hot surfaces of the vaporizer. The exhaust escapes through the passage *K*, into space *L*, around the vaporizer, and thence to the atmosphere by the valve *C* and pipe *M*.



Figs. 5 and 6. H. Campbell Oil Engine. Pat. No. 523,511, July 24, 1894.

Fig. 4 is a cross section on line *x-x* of Fig. 3. This is a very successful oil engine, and when once started will run reliably under a considerable variation of speed.

The Campbell Oil Motor.

This is a four-cycle engine. The oil is drawn into the cylinder in the form of a spray through a heated vaporizer, along with the air, at each alternate stroke. The finely-divided oil, thus injected, is well gasified by mixture with the air and contact with the heated walls of the cylinder during the suction and compression strokes. Fig. 5 is a section of the air and oil admission valve and its casing, which the inventor terms the vaporizer, but which is in reality a mixer or spraying device. The vaporization takes place mainly within the cylinder by contact with the internal surfaces and by mixing with the heated air of the charge, assisted by the churning action of the piston. Fig. 6 is a front elevation, and Fig. 7 shows the cylinder in section with the exhaust valve and its actuating mechanism.

In Fig. 7, *F* is the exhaust valve, and *D* is the base of the vaporizer, where it joins the cylinder head, at which point the mixed oil and air enter the cylinder, as shown by the curved arrow. The ignition is by means of a hot tube shown at *A* in Fig. 5.

The oil is admitted by the valve *B*, Fig. 5, and enters the vaporizer through the small holes in the seat of the air valve *C*, when the latter is drawn open by the suction of the piston. The oil and air thus mixed pass through the vaporizer into the cylinder at *D*, Fig. 7. The return of the piston compresses the mixture and forces it back into the hot-tube *A*, by which

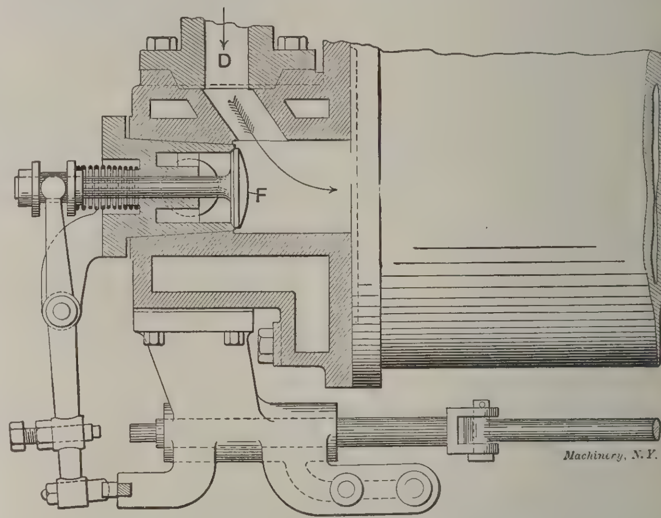


Fig. 7. H. Campbell Oil Engine. Pat. No. 523,511, July 24, 1894.

it is ignited, and the power stroke produced. This system with various modifications has been well tried, and is quite successful for stationary power.

The Diesel Engine.

This famous construction is perhaps the most scientific form of oil motor known, and it is also very successful in practice. Its development was in fact one of those rare instances in which a fine theory conformed easily to the requirements of practical use. There is a number of Diesel patents covering various details of construction, but the original one upon which the operative principle of the engine is based is the German patent of February 28, 1892, R. Diesel, No. 67,207. Patented also in the United States July 16, 1895, R. Diesel, 542,846. This invention is so widely and favorably known that an illustration of it here is deemed unnecessary, but a full description may be had by reference to the above named United States patent. The engine is used principally for stationary power in large sizes. As regards fuel consumption, it is the most economical oil motor known.

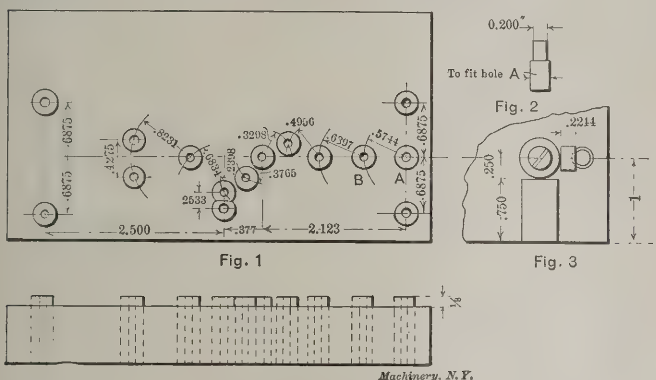
The above described systems may be taken as fairly representative of those methods of oil engine construction which have been found practical, and have been made the basis of successful manufacture, but there are several others, and the subject is one which is open to many further improvements. A common means of gasifying the oil, which does not necessarily involve the use of patented devices, is to use a cast iron retort of ample size, highly heated by the exhaust, and so arranged that it may be readily cleaned out. The oil is fed into this retort, and the vapor or gas conducted to the engine cylinder. This plan is largely used in localities where the native oil has an asphaltum base.

In the case of stationary engines running under nearly constant loads at a regular speed, oil engines have in numerous instances proved entirely satisfactory, but the automobile motor is a somewhat different, and in some respects more difficult, problem, requiring reliable action under rapidly-changing conditions; and it is only recently that any degree of success has been attained with the oil engine thus used, but there are great inducements and good opportunities for further improvement. Kerosene or common lamp oil is the kind most suitable for this purpose.

LETTERS UPON PRACTICAL SUBJECTS.

MAKING A MASTER PLATE AND USING IT FOR A DIE.

The writer has always entertained considerable respect for the height gage and buttons for accurately locating holes in jigs, dies, etc., but the accompanying description of locating the holes is, in my opinion, still more accurate. Recently we had to make a die for a register plate having 15 small holes, 0.040 inch in diameter. These holes were for a train of small clock wheels having very fine teeth. There are four dies in use in four different cities, producing this same plate, and consequently great care was exercised in making the die. When the drawings arrived we found that, instead of giving the dimensions from center lines each way to the holes, they were given by radii, as will be noted in Fig. 1, where the center distances of the clock wheels are given. The dimensions were carried out to ten-thousandths inch.



Making a Master Plate.

We all know that, when using the height gage, skill is required in handling the tool, as one must be governed by the sense of touch, and no matter how skillful a man may become in using this tool, it is impossible to accurately divide thousandths of an inch. But, had the dimensions been given from center lines, we undoubtedly would, nevertheless, have depended for accuracy on our skill with the height gage and our ability to "guess." This latter trait, however, is a poor one to cultivate in our business. We could, of course, have figured the angles and obtained the dimensions from the center lines, but chances of errors would then have been greater. We therefore decided to make a master plate, and after getting the holes exactly right, make the die from that, and we proceeded in the following manner:

First we obtained our starting point. By referring to Fig. 3, we note that the dimension from the edge to the center line is one inch. By using a button exactly 0.500 inch in diameter and making a spacer exactly 0.750 inch long, we were sure that the center of the button was one inch from the edge. The button was indicated true at *A*, and the hole bored, and a plug, Fig. 2, was turned and placed in the hole. The next hole, *B*, is on the center line, and the distance is 0.5744 inch from *A*. One-half the diameter of the plug in the hole *A* is 0.100 inch, and one-half the diameter of the button is 0.250 inch. Therefore, take the sum 0.350 from 0.5744 and it leaves 0.2244 inch, which is the distance from the edge of the button to the edge of the plug. By grinding a piece of soft steel exactly 0.2244 inch thick, and using the 0.750 inch spacer, we locate the button for the second hole as shown in Fig. 3. The button is located and the hole bored in same manner for each case until the completion of the master plate. This method is very accurate, but requires a little more time than some other methods not quite so accurate. It was our intention to insert hardened, ground and lapped bushings in the master plate, all bushings to have same size holes. Then, by soldering the die plate to the master plate and turning a plug in the center of the face-plate of the lathe to fit the holes in the bushings, the master plate could be located on the plug and strapped to the face-plate, and the die could be spot drilled and bored. The holes would then be exactly in line with the holes in the master plate. After the die was completed, the master plate could be laid away for duplicating the die, thereby saving time on the next die. But, instead of putting in bushings and making a die in this manner, we put in *bushings having holes 0.040 inch, as called for*, and, by making the bushings 1/8 inch longer than the thickness of the master plate, we were enabled to use the master plate for a die. When the bushings are ground away flush with the master plate, all that is necessary is a new set of bushings. This method may be in vogue in some shops, but it is new to the writer, and there may be many that it will benefit.

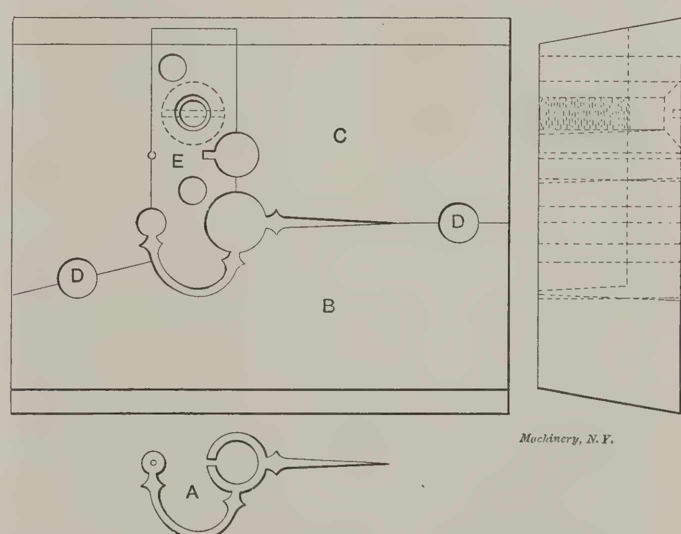
In regard to the master plate being injured by using it to make the die therefrom, would say that all first-class shops, especially watch factories, first make a master plate as nearly perfect as possible, and then make dies, jigs, gages, etc., from the master plate, the latter sometimes being termed templet. But, when used in this manner, the holes are, of course, fitted with hardened, ground, and lapped bushings. All bushings have the same size holes to permit one plug in the face-plate to answer for all holes. The master plate when converted into a die, as previously described, stands very little chance of being injured sufficiently to affect the truth of the distances between the holes, because of the fact that the bushings fit snugly the entire thickness of the master plate, which is made extra heavy. The holes in the bushings are but 0.040 inch in diameter and therefore there is but little strain on the plate.

F. E. Shailor.

Great Barrington, Mass.

SPLIT DIE FOR WATCH REGULATOR.

Much has been said of late regarding the advantages of the split die, and to no class of work does it apply more practically than to the blanking of watch movements, not only the second, minute and hour hands, but to many other parts as well. Many parts, owing to their extreme smallness and intricate shape, would be very hard indeed, if not impossible, to make in a solid or one-piece die. The accompanying cut shows a die of the common tandem type, which was made for blanking a regulator such as is used in the manufacture



Split Die, and Work for which it was Used.

of one of the popular cheap watches, and requires but little explanation. The part *A* is the blank, which is of 0.015-inch sheet steel. The two halves of the die, *B* and *C*, were nicely machined together, and it was not found necessary to grind the two together, the slight warping occasioned by hardening being practically overcome by keying the die securely in the die bolster. This was made special, and the die is never removed. The two dowel pins *D D* locate the two halves and prevent any shifting endwise. The section *E* is inserted from the side and held in place by a screw and dowels. In planing out the die for this part, the tool should have its corners rounded so as to leave slight fillets in the corners. I have seen many dies break in hardening through the failure to take this precaution.

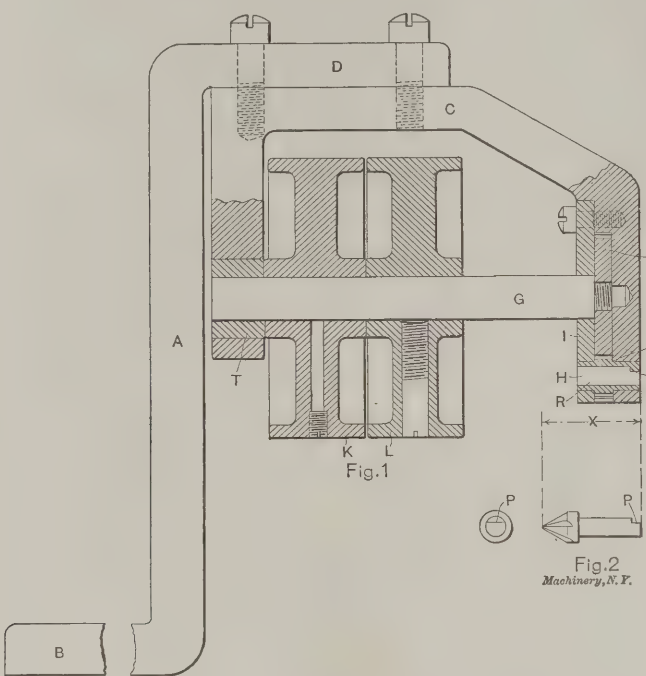
Roy Plaisted.

Hartford, Conn.

DEVICE FOR COUNTERSINKING HUBS OF WIRE WHEELS.

The spoke-holes in the hubs of wire wheels usually have to be countersunk, and the accompanying cut illustrates a device for countersinking such spoke-holes on the insides of the flanges of the hubs. In the cut, Fig. 1 is a side elevation, partly in section, of the countersinking device, and Fig. 2 shows in detail the countersink used with it.

The device is usually secured to a bench or stand. The frame consists of a Z-shaped bar *A*, bolted to the bench by bolts through the projecting end *B*. A yoke *C* is secured to the upper projection *D*. The outer part of the yoke *C* is counterbored with recesses for the gears *E* and *F*, and contains bearings for one end of the shaft *G* and for the pinion sleeve *H*. A plate *I* is screwed on to keep the gears in place, and provides additional bearing surface for the shaft and sleeve. The



Device for Countersinking Hubs of Wire Wheels.

inner portion of *C* has a bushing *T* which forms a bearing for the inboard end of the shaft *G*, and can be readily removed so as to have a hole with plenty of clearance when assembling the shaft with the pulleys *K* and *L* and the gear *E*. This latter gear is fastened by screwing it onto the reduced portion of the shaft, which is threaded right hand, and, as the shaft turns clockwise, as viewed from the left, continued turning tends to force the gear more tightly on the shaft. Fig. 2 shows the countersink adapted for use in the machine, and it will be noticed that the countersink is of the usual type, but has a flatted portion *P* at the rear end of the stem. The hole *R* in the sleeve *H* fits the countersink, and drives it by the flat *S* fitting against the flat *P* of the countersink.

This type of device has been made small enough to countersink holes in articles where the working space or distance *X* is 5-16 inch, that being the distance between the barrel and the undercut flange of the hub of the wire wheel.

Brooklyn, N. Y. C. D. King.

STANDARD LATHE SPINDLES.

There is one thing that has caused the average machinist as much profanity as anything that I know, and that is the lack of standard size and pitch for the threads on lathe spindles. Time and again jobs have come up that could be done on some idle lathe, if only the chuck or face-plate of some other lathe could be used. Of course, I know as well as anyone, that where extreme accuracy is needed, it would not do to use a face-plate not fitted to the machine, but there are hundreds of jobs that come up every year, where it would be a great convenience if the threads on the spindles on lathes of the same class were the same size and pitch.

Why cannot the lathe manufacturers get together on this subject and end the conglomeration of sizes and threads on what is just as easy to make alike? What a satisfaction to the small shop man to know that if he could not do a job on his 12-inch Lodge & Shipley lathe, with a three-jawed chuck, he had a four-jawed chuck on the shelf under his 12-inch Barnes'; this would be just the thing. The centers, too, should be the same. What sense is there in the lathe over in the corner taking a No. 3 Morse taper shank in the tail-stock, while the same class lathe next to it takes a No. 1 or a No. 2?

How few shops have, or can afford to have, a complete outfit for each lathe, and what a tremendous amount of time is lost in the aggregate all over the country by men running from the machine to the tool-room, exchanging drill chucks and sockets in their endeavor to get something to fit an odd-sized hole in the tail-stock spindle, and this, too, on lathes that have been made in the last year or two? Another annoying thing is for a man to work on a lathe, where the tail-stock screws in by turning the handle to the left, when he has been used to one which screwed in by turning to the right, as it naturally should. Apparently, the only reason for making a tail-stock so that it tightens by turning the handle to the left is that a few manufacturers think it is easier to make a right-hand screw, or else they do it to be different. If anyone ever heard of a really good reason for it, I'd like to hear it, as in fourteen years in various shops, I have never heard a valid one. Ethan Viall.

Decatur, Ill.

TOOLS FOR MAKING ARMATURE LAMINATIONS.

The cuts, Figs. 1, 2, 3, and 4, illustrate the method of producing the armature lamination, Fig. 5, of a motor, during the experimental and, later on, the manufacturing stage. In the first case the cost of tools is considered, and in the second, the manufacturing cost. In Fig. 1, *A* is a die holder for holding round dies. These holders were made for holding ordi-

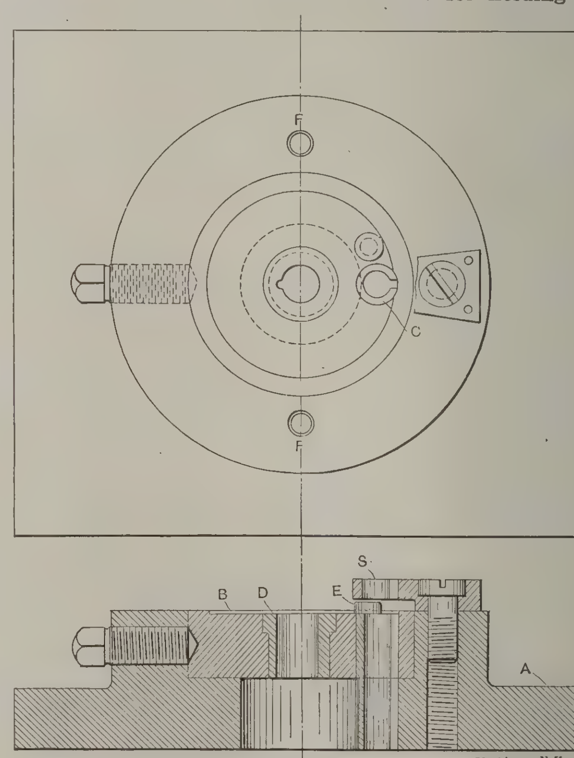


Fig. 1. Tool used during Experimental Stage.

nary blanking dies, and instead of fastening the stripper to the die, it is fastened to the bolster or holder. The first operation is punching the blank; the second is the punching of the slots. This is done with the die, Fig. 1. The pilot or index pin *E* is removed, and one slot is punched in the blank. After this operation is completed, the pin is replaced and the rest of the slots are punched, the pilot or index pin being located so as to index correctly. The die holder *B* is made from machine steel and recessed to allow the blank to fit properly; the die proper, *C*, is sweated fast in its place so as to avoid any chance of shifting its position. The die *D* is

used for the last operation, the punching of the center hole for the shaft. The stripper S is removed when punching this hole, and another is placed at F F. This latter is, of course, removed when punching the slots. The pilot pin E is used in the last operation also for locating the keyway properly in the blank. The cost of these punches and dies was small, but the manufacturing cost would come high if used to produce large quantities.

As enough of laminations were wanted to warrant a more expensive punch and die, and the manufacturing had to be cheapened, the design shown in Figs. 2 and 3 was adopted. These cuts need no further explanation as to the operation of the tool. It is readily seen that a complete lamination is obtained at each stroke of the press. A special milling cutter was made to mill the punches. Fig. 4 illustrates the method of milling the punches as well as the broach for sizing the

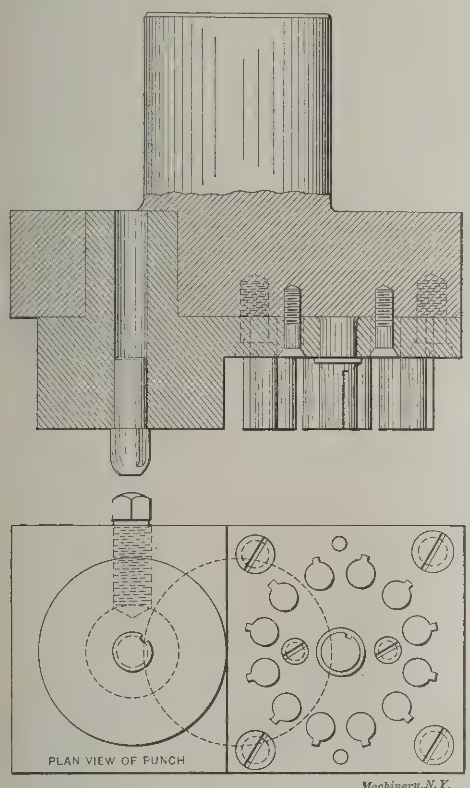


Fig. 2. Punch for Manufacturing Laminations.

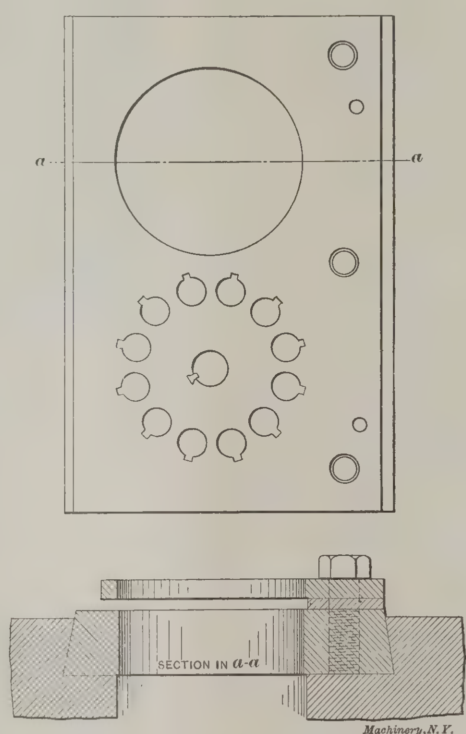


Fig. 3. Die used with Punch in Fig. 2.

Fig. 4.

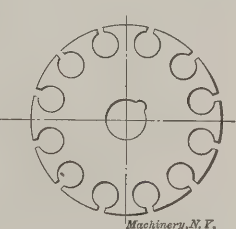


Fig. 5.

holes in the die. First both sides are milled, as shown at x', leaving a key at both sides of the punch or broach. Then one of the keys is milled off as shown at x. A small section is inserted at the center hole of the die, leaving a solid key in each blank instead of the keyway in the experimental lamination shown in Fig. 5. A. C. L.

INDUSTRIAL LIFE INSURANCE AND THE WORKMAN.

I rode in the cars the other day with a harmless-looking young fellow, whom I found to be very different from his looks, and against whom I want to warn your readers. He proved to be a life insurance agent. Now, to me, a life insurance agent is a man who ought to be shot at sight, but that is only a personal opinion and not one that I expect to see followed out. This particular chap sells or places industrial insurance. The way I happened to find it out was because after we had begun to talk he owned to his line of goods and I asked him why he had not tried to solicit me. He said: "I thought by the looks of your hands that you couldn't earn your living at a trade." His prey is the horny-handed workingman. Since the majority of your readers come under that classification, they undoubtedly know what industrial insurance means; all the more because in Massachusetts alone at this time, over a thousand of these policies are being issued every working day. If there are any who do not know, I will say that this form of insurance is ordinary life insurance in homeopathic doses, with premiums so small as to be "easy" to pay, and coming so often as to amount to practically double the rates that employers and others pay. Men who work within walls, whether blacksmiths, machinists, school teachers or molders, are known to be particularly prone to spend money foolishly. Knowing this, the industrial insurance men say they see no reason why they should not bid for it, and bid they do, and successfully. This agent gave me some figures from a report of the Massachusetts Insurance Commission showing that at the end of 1905 there were over a million of these policies in force in that state and nearly seventeen millions in the whole country.

Since I grant that life insurance is a desirable thing in any family, wherein is this friend of mine harmful? The trouble is right here, to cite freely from this same report. In the last fifteen years these companies have collected, in Massachusetts alone, \$61,000,000. They have paid back in death claims, etc., only \$21,000,000, and have left in their treasuries available for the settling of claims only \$10,000,000. The other \$30,000,000 are gone. Add to this the interest which this money would have accumulated at savings bank rates, and it amounts to the tidy sum of \$49,000,000 transferred from the pockets of wage earners to the pockets of stockholders and agents, for that is where most of it has gone. Nobody has greater need of good life insurance than the man whose income is at best but little more than his needful expenses, and no one needs it more at a low cost. Now, the real cost of life insurance is a certain thing. Life insurance is a scheme by which a large number of persons pool their savings during their lives, and the family of each member of the pool draws out that member's share when he dies. Since a certain percentage of all the people die at certain ages, it is comparatively simple to compute each dying member's share, if it is known beforehand what interest can be obtained on the money which is in the pool. If these pools were purely voluntary, that is, if they were formed by the men concerned, themselves, and managed by themselves without their receiving salaries, then the cost of insurance would be low, very low, even as compared with the rates charged on large policies, and if the money in the pool were placed where it was safe at low rates of interest, it would be good life insurance. But a man or men who conduct such a pool want all there is in it for themselves, so they charge a high rate for their services. Then, again, men do not form these pools voluntarily, so agents have to be paid to bring them in. The result is that life insurance costs the insured all that the traffic will bear, which means more to the workingman than to anyone else, just because he is not well enough posted to see that he is being mulcted. A man insured by an industrial company pays about twice what a man in a good mutual or stock company pays on a thousand-dollar policy, and he, in turn, pays nearly twice the actual cost of his insurance. In these industrial companies the expense of conducting the business is about 40 per cent of the money handled, while the savings banks do their work on $1\frac{1}{2}$ per cent of the money they handle, including taxes, which the insurance people usually manage to avoid. After seeing how badly off the work-

ingman who takes out this form of insurance is, if everything goes well, notice that in one-third of all cases the policies are allowed to lapse within three months and, in two-thirds within three years. These men simply pay and lose it all.

Then, again, the comparison is even less favorable to the workingman, because most of these companies do not pay the full face of the policy if death occurs before a certain time elapses, and as a good part of the policies are allowed to lapse before that time, it will appear that the large majority of the policies issued are either never settled at all or else settled at a discount from their face value. As an illustration, the Massachusetts report cites the fact that in 1905 the Columbian National Life Insurance Co. paid only 699 policies, either in full or in part, while 79,677 policies lapsed. Now, what does the lapsing of a policy mean? To the uninitiated it would seem to mean that the company got some money very easily, as the policy-holder never sees it again. But the company says no, as it takes three years or more to collect money enough to pay the expense of starting the policy. They pay the agent ten or twenty premiums commission when he gets the first one, so they must naturally lose on most of these lapsed premiums, and yet they all find their stock quoted way above par. My friend of the car put a new light on this point. He said: "They pay us a good commission, that is true, and they pay us a commission for collecting every premium, but we have to be responsible for the premiums on the policies that we solicit. That is, if you take out a policy with me and you carry it along for three or four months I get $2 for soliciting it, if it is a ten-cents-a-week policy, and I get two cents a week for collecting, but if at the end of three or four months you stop paying, then I have to pay it or drop my job; that is, I am eight cents a week out till the company has got back all the actual, and some imaginary, cost of getting your policy." By this means the companies appear to pay good commission, and yet really they protect themselves by shifting the responsibility for collections on their agents. To the agent the all-important thing is to get new business. If he is carrying my policy along at a loss of eight cents a week, if he can solicit Tom or Dick for a ten-cent policy, he makes his $2 on the spot and he uses it to carry my policy along for twenty-five weeks.

Then look at the way these policies are solicited. You are struggling along, never really getting much ahead. You have a wife and babies. The agent comes to see you; he gets you to get your wife in the room, which is *your* fatal mistake. Then he begins to draw pictures of your poor wife and children left without even the money to bury you with, cast adrift, furniture sold to pay the rent, and all the time your wife is thinking about your telling her of the chap that was caught on a shaft a few days ago and whirled around and picked up for dead or worse. Before he leaves, you have taken a policy that will cost you a dollar a week. Before long you begin to feel that you must let one week go by; there is the new suit of clothes, and the piano, and the kitchen stove, and any number of other things all drawing a dollar a week. These other things are tangible; if you don't pay the installments, the furniture van will back up, but when your policy lapses you don't perceive any change in your condition. What you have lost is intangible, and you can renew it later. But every time you renew, your policy is a little less in value for the same premium, so part of your money is gone, anyway. "What would I suggest?" Why, take out a policy just as your employer would. Make it a thousand dollars; it won't cost you any more than five or six hundred will with the industrials. Pay your premium quarterly if you want; it won't be more than six or seven dollars at a time. Give your wife half a dollar every pay day and let her keep the policy and keep it up. She is the interested party and she will do it. Women may have a weakness for millinery, but they don't travel past nearly so many grog shops every day as you do, and most of them have a better eye to the future than men have. If you cannot afford even this, take out a term policy; this is one that runs only for a limited time, say seven or ten years. The rates are much lower, but be sure you get what is known as a "convertible" term policy, so that at the end of the term you may take out a new policy, in any form which you may wish, without a new examination. CON WISE.

CONVERSION OF AN OLD PLANER INTO A MILLING MACHINE.

The cuts, Figs. 1 and 2, show an old obsolete planer which, having been in operation for twenty-four years, was recently converted into a milling machine through the application of a No. 2 Farwell milling attachment. I have frequently seen

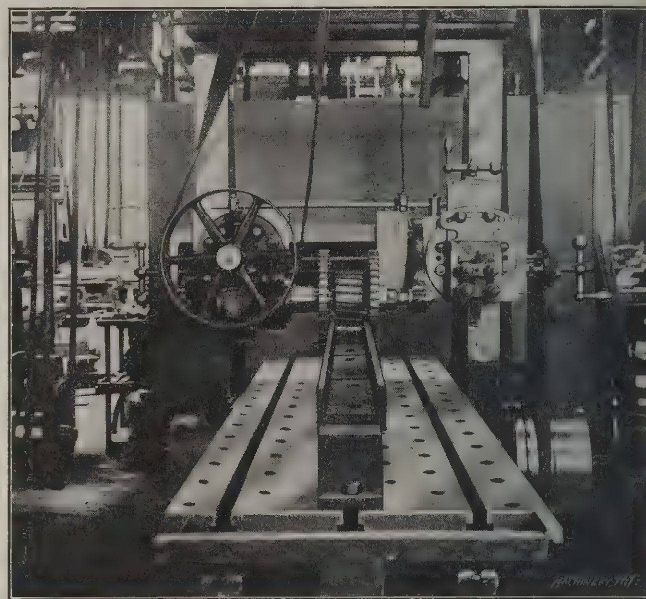


Fig. 1. Old Planer Converted into Milling Machine.

heavy slab milling machines at work milling the two outsides of locomotive shoes and wedges, but by merely drilling a countersunk hole in each shoe and fastening a number of them to a suitable jig, as shown in Fig. 2, several of them can be milled on the inside and outside at the same time. By using this milling attachment on the planer we can do as many in four hours as we formerly did on the planer itself in nine hours. It takes, on an average, one hour to grind the cutters in every twenty hours of service. Before grinding the

Fig. 2. Jig used for Holding a Number of Shoes and Wedges.

large end cutters, as soon as one side gets dull, I change them around on the arbor so that both sides get an opportunity to be at work before resharpening them. This way of finishing the shoes and wedges may not be original, but I have not as yet seen it done in this manner in any of the shops where I have been. M. H. W.

HOW JOHNNY SUCCEEDED IN GETTING AN INCREASE IN WAGES.

Johnny had been waiting for nearly a week to catch the boss when he was feeling good-natured to "strike him" for more pay. One morning the boss came around feeling in the best of spirits, and Johnny promptly took advantage of his opportunity. "Let's see, how many times have I given you a raise during the past year?"

"Twice," said Johnny.

"You are now receiving $2.50 per day; don't you think that is pretty good pay for a boy that has been 'out of his time' only a year?"

"No, sir; not when I notice that you pay green men $3.50 per day, and after they spoil the job you discharge them and turn the job over to me to make. If a new man is worth

$3.50 a day to spoil work, I surely must be worth $2.75 to satisfactorily complete the job."

"Those men you speak of hired out as first-class men; they lied to me and were promptly discharged, and I fail to see wherein their inefficiency has anything to do with your claim for more pay. What you need is more experience, and then more pay will be forthcoming."

Said Johnny: "My argument is, that it is not experience that counts so much as one's ability, for in this particular case these men have certainly worked at the business longer than I, but were unable to do the class of work that I am doing. For instance," continued Johnny, "suppose that the *very best* tool-maker in the United States should come along here and hire out for $2.50 per day claiming that he had not been at the business very long, how long would he be obliged to work here to receive $3.50 per day? How often would you raise him—every six months, as you do me?"

"If he was worth more money I should promptly give it to him."

"Well, cutting out this 'experience' part of it and talking from the standpoint of a man's worth, don't you think that I am worth $2.75 per day?"

"Well, I guess you are, Johnny. I'll start you next week at $2.75." S. E. F.

THE POSITION OF THE CHECK NUT.

A mistake which is often made in machine design and building, and which sometimes can be found even in our best and most reliable engineering hand books, is to put the check nut used for the securing of an ordinary nut on the top, instead of at the bottom, of the regular nut. A little consideration in regard to the intensity and directions of the forces acting on the two nuts will very plainly show that the right place of the check nut is under the ordinary nut.

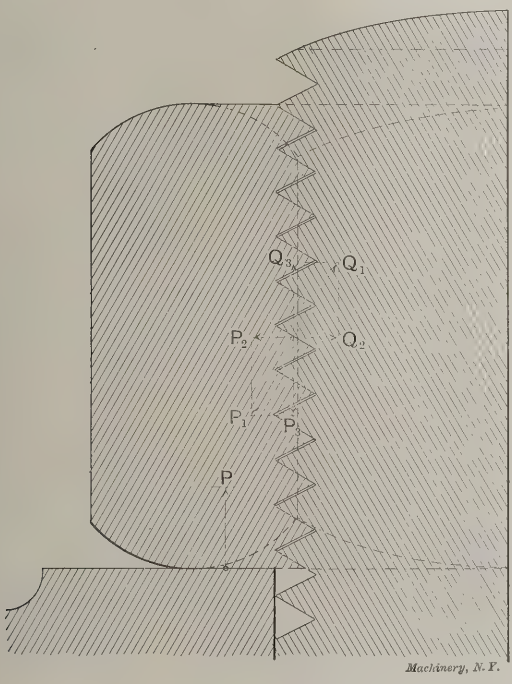


Fig. 1. Action of Forces, Single Nut.

In common practice the check nut is given a height equal to half the height of the ordinary nut, which latter commonly has a height equal to the diameter of the engaging bolt. Fig. 1 illustrates a case where only one nut is being used. Considering the forces, P is a force due to the tightness with which the nut has been screwed into place, and is acting on the lower surface of the nut, and directed upward. P_1 is a force due to same cause, acting from the threads of the screw on the threads of the nut, and directed downward, making a right angle with the surface of the thread. This force P_1 can be divided up into two components—one, P_3, directed downward, parallel with the center-line of the screw, and one P_2 at right angles to the same. The force P_3 is equal to and directly opposite P. Both are acting on the same piece, and they are, therefore, in equilibrium. The force P_2 is in equilibrium with the internal stresses in the nut. As will be seen in Fig. 1, only the upper surfaces of the threads of the nut are bearing against those of the screw, a slight play being left between the other thread surfaces. This play is due to the fact that neither the screw nor the nut ever can be made absolutely exact, and the play is, in fact, necessary in order to enable the nut to be screwed on.

The case where a check nut is used for the purpose of securing the ordinary nut is illustrated in Fig. 2. The forces acting on the upper nut will be equal, both in regard to intensity and direction, to those in the case of where only one nut is employed. Considering the lower nut, we have, acting on this, the force P, due to the pressure of the upper nut and directed downward, and the force p, due to the pressure

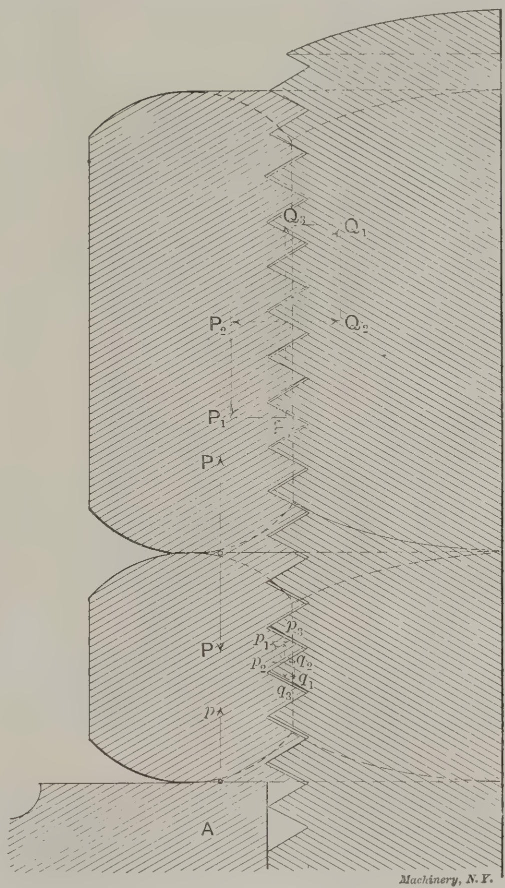


Fig. 2. Action of Forces, Check Nut Used.

from below, and directed upward. These two forces together give a resultant equal to $P - p$, directed downward, which is in equilibrium with the force p_3, the vertical component of the force p_1. This represents the pressure from the upper surface of the thread of the screw on the lower surface of the thread of the nut. The other forces shown in Fig. 2, their directions and relative relationships, can easily be seen from the diagrams.

It is plain that the pressure on the threads of the lower nut is directed upward. Therefore, the threads of the upper nut have to take the pressure from the body A, that is, all the pressure caused by tightening the nut, and, in addition, all the pressure on the threads of the lower nut. The pressure on the threads of the lower nut is very small compared with that of the upper nut, a fact which proves beyond doubt that the upper nut should be stronger than the lower one.

High Bridge, N. J. OSKAR KYLIN.

METHOD OF ANNEALING NOVO STEEL.

A great many times a machinist wants to use a piece of Novo steel for some special job, but, not having a piece that is soft enough to work, he uses carbon steel instead, generally because he does not know how to anneal high-speed steel, and imagines that an elaborate heating system must be used. I have met dozens of blacksmiths, tool-dressers, and machinists who declared that the thing was impossible, but who quickly changed front when showed how. Not long ago, a writer in

one of the prominent mechanical journals, who said he had done nothing but worked with steel all his life, described his process for annealing Novo steel. He packed it in a tube or iron box in ashes, clay or charcoal, put it in the furnace, and kept it at 800 degrees F. for five hours, then at 900 degrees F. for seven hours, and then he let the fire go out, and removed his steel from the furnace twelve hours later.

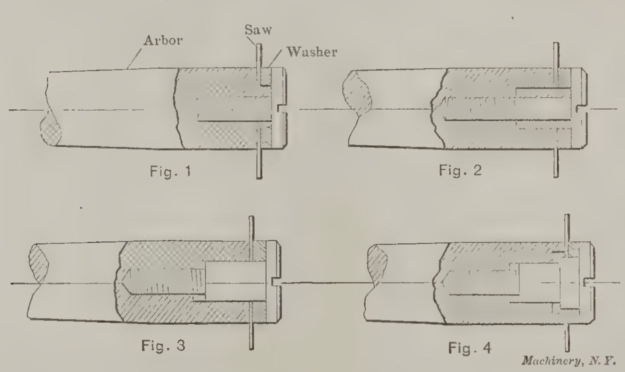
This method seems rather inconvenient, however, and the writer would propose the following: If you have a piece of Novo steel that you want to soften so that you can drill, file or tap it, get a barrel of old slacked lime and a piece of pipe, threaded on both ends. Get a pipe large enough to allow the steel plenty of room. Put a cap on one end and put in about an inch of lime at the bottom, drop in the steel and pack lime around it, keeping the steel in the middle of the pipe, and fill the other cap with lime and screw on. It will be well to explain here that the whole secret of annealing this or any other steel is to keep it from coming in contact with the air and thereby chilling while in the process of cooling.

Next put the pipe and contents into the fire, and heat slowly and evenly to a white heat, then take out the pipe and bury it quickly in the middle of your barrel of lime and leave it twelve or fourteen hours. For ordinary sized pieces the time taken to heat will not be over twenty minutes, and if you have a good-sized forge it will be considerably less. Be sure the steel is heated through before taking it from the fire. I have annealed hundreds of small pieces of Novo steel in this way, and have never yet met with a failure. E. VIALL.

Decatur, Ill.

SOME TYPES OF SAW ARBORS.

In manufacturing, as well as in the ordinary machine shop, the types of saw arbors shown in the cut are used to a great extent on account of the small space required outside of the saw, a screw being used in place of the regular nut. The question has come up a number of times as to which of the de-



Types of Saw Arbors.

signs shown in the sketch is the best. The sketch shows four of the common designs, and the writer has seen preference given to different ones by different shops, and would like to have the opinion of the readers of MACHINERY as to which is the best design.

Fig. 1 shows the old, common, soft arbor, which still holds its own in many places. Fig. 2 shows one that will bear consideration, the hard bushing giving it an advantage over the one in Fig. 1. This arbor is also soft and can be trued up at any time. This is another good point in its favor. The arbor shown in Fig. 3 was a favorite with an old boss of mine, and he had many reasons, the principal one being that the arbor could be used for a thicker saw without extra washers and still hold its principle, that of having the saw at the extreme end of the arbor. This is the only advantage I can see over the one in Fig. 2. The arbor in Fig. 4 is of the same general type as the one in Fig. 3, but has an additional advantage; the arbor can be used with a saw of another size hole by simply changing the screw. ARTEBE.

SIMPLE SOLUTION OF HOPPER PROBLEM.

In the "How and Why" columns of the May issue of MACHINERY formulas were given for computing the angle between the slope sheets of a hopper, the pitch of the sides being known. These formulas are unhandy for use and, as a much more simple expression can be obtained without the use of more complex mathematics, I suggest the following:

AH and AK are slope sheets of a rectangular hopper and intersect in AB. BG is a perpendicular to EAF, the plane of the top of the hopper. CB and DB are respectively perpendicular to the edges AE and AF. $\angle GBC = \alpha$ and $\angle GBD = \beta$, α and β being the angles which the sides make with the vertical. EB and FB are each perpendicular to AB, hence $\angle EBF$ is the angle between the sides AH and AK.

According to principles of elementary trigonometry,

$$\cos EBF = \frac{\overline{EB}^2 + \overline{FB}^2 - \overline{EF}^2}{2\,EB \times FB} \qquad (1)$$

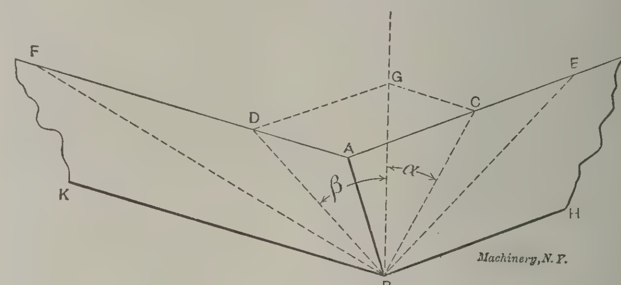


Fig. 1.

But since EAF, ABE and ABF are right angles

$$\overline{EF}^2 = \overline{EA}^2 + \overline{FA}^2$$

and

$$\overline{EB}^2 + \overline{FB}^2 - \overline{EF}^2 = \overline{EB}^2 - \overline{EA}^2 + \overline{FB}^2 - \overline{FA}^2 = -2\,\overline{AB}^2 \quad (2)$$

In the right triangle EBA

$$EB = AB \tan EAB.$$

We can see that

$$\tan EAB = \tan CAB = \frac{CB}{AC} = \frac{CB}{DG} = \frac{BG \sec \alpha}{BG \tan \beta}$$

$$\text{hence } EB = AB \times \frac{\sec \alpha}{\tan \beta} \qquad (3)$$

$$\text{and similarly } FB = AB \times \frac{\sec \beta}{\tan \alpha} \qquad (4)$$

From (1), (2), (3) and (4) we easily get

$$\cos EBF = -\frac{\tan \alpha \tan \beta}{\sec \alpha \sec \beta} = -\sin \alpha \sin \beta \qquad (5)$$

In the usual construction of hoppers, each side will slope outward, $\sin \alpha$ and $\sin \beta$ will have like signs and $\cos EBF$ will be negative, indicating that the angle is greater than a right angle.

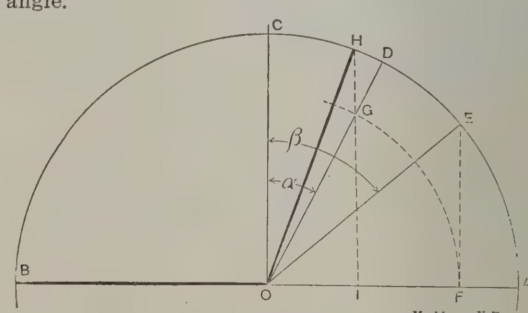


Fig. 2.

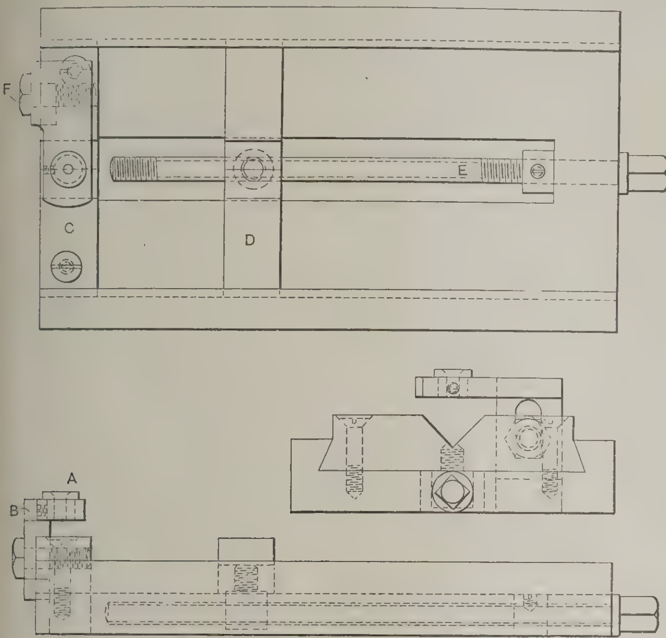
To illustrate the use of formula (5) let $\alpha = 27$ degrees and $\beta = 50$ degrees.

Then—sin α sin β = —sin 27 degrees × sin 50 degrees = —0.4540 × 0.7660 = —0.3478, the cosine of 110 degrees 21 minutes. The required angle is, therefore, 110 degrees 21 minutes. The result may be obtained very easily by the following graphical method:

In Fig. 2 the semicircle BCA may be drawn to any radius. CO is perpendicular to the diameter BA. Make $\angle DOC = \alpha$, and $\angle EOC = \beta$. Project E to F on AB. With radius OF describe an arc about O, cutting OD in G. Project G to H on semicircle. Join H and O; then HOB is the angle required. M. D. G.

PIN HOLE DRILLING JIG.

The cut herewith shows a jig for drilling pin holes in studs. This device will handle a variety of such work with great rapidity. The drill bushing *A* can be removed and bushings with different size holes inserted. The bushing holder *B* can be raised or lowered to suit different diameters of work. The V block *C* is fixed, while block *D* is adjustable by means of the screw *E* for different lengths of studs. By fastening a



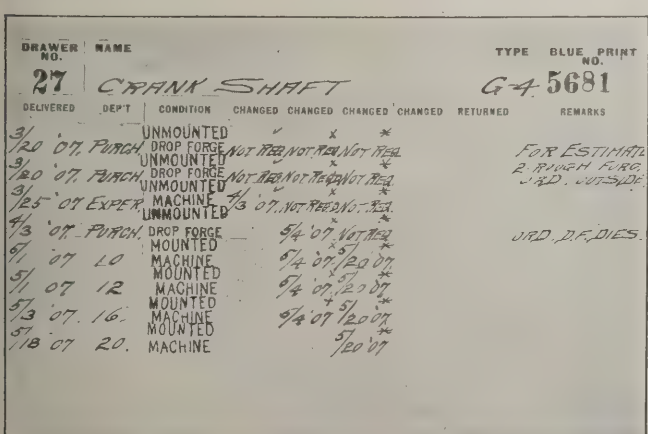
Pin Hole Drilling Jig.

strap to the device by screw *F*, and providing this strap with an adjusting screw in line with the V's, studs can be gaged from the end instead of from the shoulder. The manner in which this jig is used lends itself well to a variety of work of all descriptions. PAUL W. ABBOTT.

Lowell, Mass.

BLUE-PRINT RECORD CARD.

A firm whose line of work is such that improvements and changes of designs and details are constantly being made, as is the case in the automobile business of to-day, must by necessity devise some system of properly keeping track of the blue-prints in the factory. In an establishment where there are several hundred prints in twenty to twenty-five different departments, it is very necessary that there be some good sys-



DRAWER NO. 27 | NAME CRANK SHAFT | TYPE G-4 | BLUE PRINT NO. 5681

DELIVERED	DEP'T	CONDITION	CHANGED	CHANGED	CHANGED	CHANGED	RETURNED	REMARKS
3/20 '07	PURCH.	UNMOUNTED DROP FORGE	NOT REQ.	NOT REQ.	NOT REQ.			FOR ESTIMATE
3/20 '07	PURCH.	UNMOUNTED DROP FORGE	NOT REQ.	NOT REQ.	NOT REQ.			2 ROUGH FORG. ORD. OUTSIDE
3/25 '07	EXPER.	UNMOUNTED MACHINE	4/3 '07	NOT REQ.	NOT REQ.			
4/3 '07	PURCH.	UNMOUNTED DROP FORGE		5/4 '07	NOT REQ.			ORD. D.F. DIES.
5/1 '07	10	MOUNTED MACHINE		5/4 '07	5/20 '07			
5/1 07	12	MOUNTED MACHINE		5/4 '07	5/20 '07			
5/3 '07	16	MOUNTED MACHINE		5/4 '07	5/20 '07			
5/18 07	20	MOUNTED MACHINE			5/20 '07			

Blue-print Record Card.

tem of keeping in touch with every blue-print, in order that the proper ones may be corrected when a change is made.

The card shown in the cut is one devised by myself, and used to great advantage by The Garford Co., to keep track of all blue-prints issued from the drafting room. Each part of our machines is detailed on a separate standard sheet, and mounted on pressboard for the shop. Each department has also a complete book of blue-prints for each type of automobile. When a change is made on a drawing, a new blue-print is made to supersede each blue-print in the factory. On issuing a blue-print from the drafting room, a card like the one here shown is filled out. The name of the piece is entered in the place marked "Name." Blue-print number and drawer number (which is the drawer where the tracing is filed) are placed on with a stamp in their proper places. In the column marked "Delivered" the date is entered, and the department number placed in the column marked "Dep't." Under the heading "Condition," the mounting and kind of the blue-print is noted, either mounted or unmounted, machine, drop-forge or pattern drawing. For this, a rubber stamp is used. When a change is made in the tracing, by looking on the proper card, it is readily seen where the blue-prints are, and which ones are to be changed. In the columns "Changed," the date when the new blue-print is delivered and the old one is returned, is noted. If for any reason it is not necessary to change the blue-print in some departments, a check or some other mark is placed in the space instead of the date, and a similar check or mark placed on the back, and the reason noted. If, for instance, the piece was a casting and some drilled hole is changed from one-quarter inch to three-eighths inch, it would not be necessary to change the blue-print in the pattern shop. Each department has its own blue-prints and they are never delivered from one department to another without first going through the drawing room. When the department is through with the blue-print, it is returned to the drawing room, and the date entered in the column marked "Returned." The above system works to good advantage, and may be of value to others. A. B. HOWK.

Elyria, O.

GRINDING GEAR-CUTTER TEETH TO LENGTH.

Referring to the July issue of MACHINERY, I note the article "Importance of Grinding Gear-Cutter Teeth Radially." I am a little surprised that the same article did not call attention to another feature which is as important as the one brought forth, being that when the teeth are ground back from the base, all teeth should be ground an equal distance. Otherwise, those teeth which are ground the least will have to do all the cutting. F. H. STILLMAN,

New York. Watson, Stillman Co.

[A simple method that is commonly used in grinding cutters to insure that all the teeth shall do an equal share of the work is to grind only those teeth that are most dulled on the points. These are the teeth that have been doing the greatest amount of work, and should be sharpened more than those that are not dulled. After careless grinding it will be found that some teeth have done little or no work at all. These teeth, of course, should not be touched in regrinding. In this manner the requirement mentioned by Mr. Stillman may be very easily met in grinding gear cutters.—EDITOR.]

* * *

Two of the most notable and, perhaps, the handsomest skyscraper structures in lower New York are the Trinity Building with its new annex and the Realty Building adjoining, both being of the same Gothic style of architecture. The Trinity Building was built three years ago on a very narrow plot of ground adjoining Trinity churchyard, and its general style is in keeping with the venerable Trinity Church. Then an adjoining plot of ground, north, was acquired, and the location of the narrow Thames St. was shifted northward a short distance to permit of the building of an annex to the Trinity Building. This change reduced the size of the Realty Building lot to approximately the same width, so that both buildings are of about the same size. The Trinity Annex and the Realty Building were erected in record time. The first steel columns were set September 15, 1906, and both structures were opened May 1. Both structures are 21 stories high, and they represent a total investment of about $15,000,000. Perhaps there is no spot in New York where the impressiveness of these great modern office structures of lower New York can be realized so well as on Trinity Place, looking up through the narrow canyon-like streets separating the new buildings and the adjacent buildings on the north.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

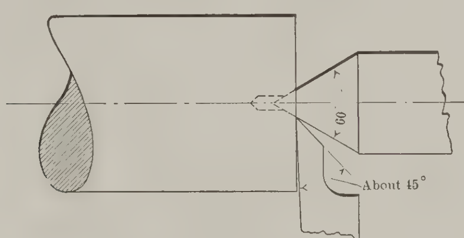
TO SHARPEN LEAD PENCILS.

The rotary pencil sharpeners are a boon to the pencil manufacturers, especially where hard pencils are used. The pencil supply in a certain drafting room, which was usually ordered every six months, was exhausted in less than four months since one of the standard ordinary pencil sharpeners had been installed. The best and quickest method for pointing a pencil is to lay a half-inch carpenter's chisel down on the drawing board with the bevel on the lower side and the edge away from the body. Then draw the pencil across the edge of the chisel toward the body and at an angle of about 15 degrees to the board. The results obtained are very satisfactory. E. A. PRITCHARD.

Champaign, Ill.

FACING WORK ON CENTERS.

The common method of facing work between lathe centers consists in slightly unscrewing the tail-spindle to allow the side tool to approach the center of the work. This is a very bungling method, and often causes botched work; but it must be quite general, for the writer has known it to be used in



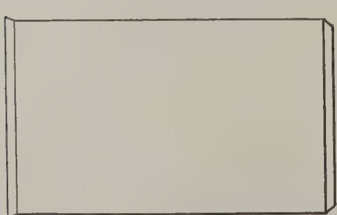
Machinery, N.Y.

different sections of the United States, and it is given as the proper method in one of the most progressive works on shop practice. A better way is illustrated herewith. It will, of course, be understood that the object of unscrewing the tail-spindle is to allow the point of the tool to cut away the slight tit or ridge that is sometimes left at the center of a shaft; but if the side tool be ground to about 45 degrees, as shown in the cut, there will be no trouble in facing the end of the work quite flat, without slackening the tail-spindle. As an instructor in shop practice, the writer has always followed the method here advocated. W. S. LEONARD.

Atlanta, Ga.

DRIFT FOR BABBITTED BOX.

Did you ever have a "hurry up" job babbitting a solid box, and have to spend three-quarters of the time scraping the box out for a running fit? One way to overcome this is to take a short piece of shafting, and with a light hammer upset one end so that it becomes about one-hundredth of an inch larger in diameter. File or grind the sharp corner from the other end. This makes a handy drift which can be driven through the babbitted box, expanding the babbitt tight in position, and making an easy running fit for the shaft. STANLEY GOULD.



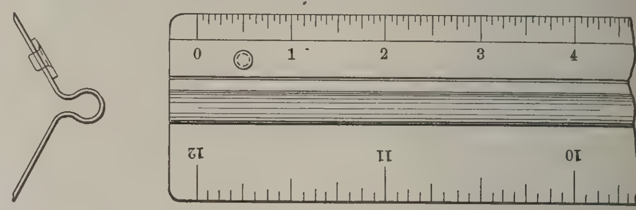
Machinery, N.Y.

Los Angeles, Cal.

ATTACHMENT FOR DRAFTSMAN'S SCALE.

The cut herewith shows a very simple means of converting the ordinary draftsman's scale, graduated to 1-16 and 1-32 inch, as manufactured by Brown & Sharpe Mfg. Co., into a scale that can be used for scaling or making drawings half size. The attachment consists of a narrow brass or steel strip with four or more pins inserted and riveted to it. These pins fit into holes which are drilled in the scale. A still better construction could be obtained by forming heads on the rivets, and having button-hole slots in the scale. If it is desired to adopt the scale for half-size work, number each ½ inch consecutively as full inches. For quarter size, each ¼ inch should be consecutively numbered with whole numbers.

Applied as shown, on the 1-32 inch side each graduation reads as 1-16 inch. The appliance shown serves the purpose nicely, but it is rather unfortunate that, in the present day of advancement one is obliged to contrive a makeshift. There



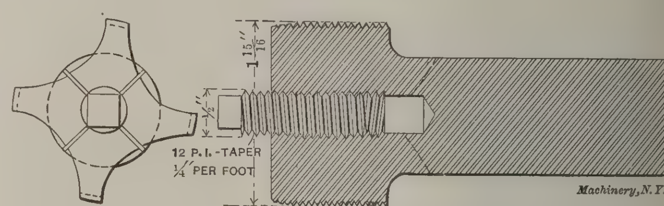
Machinery, N.Y.

is no doubt but what scales of the design shown, graduated ¼, ½ and ¾ inch to the inch, would find a sale equal to the full size scale. WINAMAC.

[The B. & S. scale mentioned is made in a variety of graduations up to and including 3 inches = 1 foot.—EDITOR.]

INEXPENSIVE EXPANSION TAP.

The expansion tap shown in the accompanying cut may not be new to some of the readers of MACHINERY, but it is one which gives the best of satisfaction. It is intended for the turret lathe, the shank fitting in the hole of the turret. It is expanded by means of a taper screw having a taper of ¼ inch per foot. The screw shown in the cut is provided with a square head, but all screws smaller than ½ inch are slotted for a screw driver. The holes in the tap are tapped straight with ordinary plug hand taps. With the screws tapered and the holes straight, it is evident that the bearing is at the outer end all the time, and the tap is expanded by screwing in the screw. It will be noticed that the flutes are not milled



Machinery, N.Y.

as deep as in a regular tap of the same size. The smallest expansion tap that we have as yet made on this principle is 9/16, 24 threads per inch. These taps have been in use long enough to prove that they are better than ordinary taps when one has to keep the threaded holes within limits of 0.001 inch. C. L. VANERSTROM.

Detroit, Mich.

HOW TO CLEAN YOUR HANDS.

Here is something that everybody does not know about. A tinner told me about it after I had nearly rubbed the skin off, a good many times, trying to remove soldering acid from my hands. Have a package of "Pearline" handy, and, by using a small amount, all traces of acid can be very easily removed, leaving the skin soft and clean. It will clean dirty, greasy hands when nearly everything else fails. It is great for printers, as it removes ink with great ease. Have a nail brush handy, and you can, in a few minutes, put your hands in shape to attend a card party, even after the dirtiest kind of a job. X. Y. Z.

* * *

In a reply to a correspondent who asks if it is advisable to use soft metal punches in connection with hard dies in press working of brass to produce ornamental designs, *Copper and Brass* states that soft punches are used extensively in drop presses for this purpose. They are cast directly in the dies, the best mixture being an alloy of 2 parts lead and 1 part tin. The punch retains its shape under a quick powerful blow by reason of the momentum of the particles, each of which tends to force the sheet metal ahead of it so as to perfectly fill the die.

SHOP RECEIPTS AND FORMULAS.

A DEPARTMENT FOR USEFUL MIXTURES.

This page is intended to be used only for the publication of such shop receipts as the contributors know from experience to be practicable. Receipts are solicited on the condition that the contributors personally know that they are reliable. The fact that a receipt is old and supposedly well-known does not bar it, provided it has not already appeared here.

With this issue the department of shop receipts and formulas is discontinued as a regular monthly feature. During the past two years nearly 400 receipts have been printed, many of them old and well-known, and others never before made public. That the department has been a popular and valuable one we are well assured by the many commendatory letters received and by the demand for the little booklet containing reprints of 150 of the most used receipts. This booklet will be revised soon and doubled in size.—EDITOR.

375. SILICATE OF SODA CEMENT FOR GRINDER DISKS.

We use silicate of soda (liquid glass) for fastening emery disks to a disk grinder, and think it is the best cement we ever tried. It requires no haste in applying, and the hotter the disk gets, the tighter it sticks. H. G. HERRICK.

Syracuse, N. Y.

376. TO CUT OFF GLASS TUBES.

Saturate a cotton string in kerosene, wrap it around the glass tube where you wish to have it cut, set fire to the string, and when all parts are ablaze, plunge the glass in a pail of water. Give the top of the glass a light blow with a stick, and there will be an even break all around.

Detroit, Mich. CHARLES SHERMAN.

377. TO GLUE ASBESTOS OR OTHER FABRIC TO IRON.

One of the most reliable cements or glues to use for attaching asbestos or any other fabric to iron is silicate of soda. It is successfully used for attaching emery paper disks to disk grinders. It is particularly useful for attaching asbestos to furnace pipes, because it stands heat well, and for this reason silicate of soda is an all-around cement of much value.

M. E. CANEK.

378. TO JAPAN CASTINGS.

Clean the castings well and paint them with pure boiled linseed oil. When the oil has dried, bake the castings in an oven at such a temperature as will turn the linseed oil black, japanning, and then the glossy black surface will show to good results the castings should be carefully smoothed off before japanning and then the glossy black surface will show to good advantage. A better mixture is asphaltum, 1 ounce; boiled linseed oil, 1 quart; and burnt umber, 2 ounces, thinned with turpentine. M. E. CANEK.

379. SILVER SOLDER FOR BRAZING.

Much difficulty arises in the use of brazing solder. The best alloy to use in brazing is the common silver solder. It has the advantages of a low melting point and toughness, which are not found to such a high degree in common brazing brasses composed of copper and zinc. The melting point of silver being lower than that of copper, and as it does not oxidize when heated, it is admirably adapted for use in brazing solder. The proper mixture for the solder consists of two parts fine silver filings and one part fine brass, which latter consists of 2 parts copper and 1 part zinc. T. E. O'DONNELL.

Urbana, Ill.

380. SOLDERING PASTE.

By the requirements of the electrical trade in certain cases no acid soldering flux can be used. A flux that can be used on any kind of work is known as a soldering paste. For soldering copper wires and other electrical conductors the paste is unequaled, and is particularly adapted for work in which spattering and corrosion are objectionable. The mixture for soldering paste consists of certain proportions of grease and chloride of zinc. The grease commonly used is petrolatum or vaseline, which will give the paste the proper consistency. The proportions used are petrolatum or vaseline, 1 pound, and 1 fluid ounce saturated solution chloride of zinc.

Urbana, Ill. T. E. O'DONNELL.

381. SILVER SOLUTION FOR ELECTRO-PLATING.

Put together, into a glass, one ounce silver, made thin, and cut into strips, two ounces best nitric acid, and one-half ounce clean rain-water. If the solution does not begin to act at once, add a little more water, and continue to add a very little at a time until it does. In the event it starts off well, but stops, before the silver is fully dissolved, it generally may be started up again by adding a little more water. When the solution is entirely effected, add one quart of warm rain-water and a large tablespoonful of table salt. Shake well and let settle; then proceed to pour off and wash through other waters. When no longer acid to the taste, put in 1⅛-ounce cyanuret potassa and a quart pure rain-water. After standing about twenty-four hours it will be ready for use.

St. Louis, Mo. SAMUEL STROBEL.

382. ENAMEL FOR IRON OR STEEL.

Make an enamel by mixing 2 ounces of burnt umber with 1 quart boiled linseed oil, heating, and then adding 1 ounce asphaltum. Keep hot until thoroughly mixed, and thin with a small quantity of turpentine. Have the surface of the parts to be enameled thoroughly cleaned, and apply the enamel with a camel's hair brush, and allow it to set. Then place in an oven and bake for 6 hours, at a temperature of 250 degrees F. When cool, rub down with steel wool, and then apply the finishing coat of the desired color, and allow to bake for 6 or 8 hours. Rub down, when cool, with a soft cloth, then varnish and bake again at 200 degrees F. The heating and cooling should be done gradually each time so as not to crack the enamel. Black enamel usually requires a higher degree of temperature than any other kind, or about 300 degrees F. T. E. O'DONNELL.

Urbana, Ill.

383. ACID DIP FOR BRONZE CASTINGS.

A very suitable and effective acid dip for bronze castings may be made up in the following manner. The constituents required are one gallon pale aqua fortis, one gallon oil vitriol, four quarts of water, eight ounces of rock salt. In mixing the acids add the vitriol to the aqua fortis, after which the water should be introduced, by pouring in very slowly into the acid solution. Water should never be poured into the acids, separately. When the water and acids have become thoroughly mixed, the salt may then be added. The solution becomes quite warm after mixing, which is a good time to add the salt, as the heated solution dissolves the salt readily. After mixing, the solution should stand from 10 to 12 hours before using. It is best to make a large quantity of the solution if much dipping is to be done. To secure the best results it is necessary that the solution be kept at as low a temperature as possible, hence it is advisable to place the receptacle in a tank of cold water, or what is better, place it in running water.

Urbana, Ill. T. E. O'DONNELL.

384. ZINC DUST CEMENT.

A putty prepared with zinc dust does not have the drawbacks of those prepared with white lead or red lead. The oil used is that known as wood oil; this oil is extracted from a tree which grows in China and Cochin-China, known as the oil tree or *Eloecocca Vernica.* This putty possesses the peculiar property of hardening under the action of a very moderate heat, such as that which exists in steam boilers. With linseed oil, the hardening takes place at a higher temperature, but it is not as thorough, and a partial oxidation takes place, and it is accompanied by the production of carbonic-dioxid. With wood oil, the hardening is entire and rapid, and a rearrangement of molecules takes place without any chemical change; the physical constitution alone appears to be modified. The hardening of zinc dust cement is quite different from that prepared with white or red lead, as the action of oxygen is not required. Heating to 150 degrees centigrade is sufficient to complete the action, and at 110 degrees it is completed in six hours. This cement will keep for an indefinite period after hardening. ALFRED LANG.

Pittsburg, Pa.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address The latter are for our own convenience and will not be published.

OVERSIZE LIMITS OF TAPS.

Tap-maker. In the July issue of MACHINERY a table was given stating the limits of oversize in diameter of hand taps. Does this table refer to hand taps only, or should all kinds of taps be made according to the figures there given? Are the dimensions in the table derived from actual practice, or have they been merely estimated or figured from some arbitrary formula?

A.—The figures given in the table referred to, cover all ordinary hand taps and all taps which, while not generally termed hand taps, are used in the same or in a similar manner, as, for example, pulley taps, screw machine taps, boiler taps, etc. Other classes of taps are made as stated in the tables below.

TABLE I. LIMIT OF OVERSIZE IN DIAMETER OF MACHINE SCREW TAPS AFTER HARDENING.

Diameter of Tap, inches.	Limit of Oversize.	Diameter of Tap, inches.	Limit of Oversize.	Diameter of Tap, inches.	Limit of Oversize.
$\frac{1}{16}$	0.00075	$\frac{5}{32}$ — $\frac{3}{16}$	0.00125	$\frac{9}{32}$ — $\frac{5}{16}$	0.002
$\frac{3}{32}$ — $\frac{1}{8}$	0.001	$\frac{7}{32}$ — $\frac{1}{4}$	0.0015	$\frac{11}{32}$ — $\frac{7}{16}$	0.0025

Hobs and die taps are made to somewhat closer limits in regard to the excess diameter. The figures given in the table below should not be exceeded under any circumstances, as a hob, the error in lead of which is so great as to require a larger excess in diameter than given, should not pass inspection.

TABLE II. LIMIT OF OVERSIZE IN DIAMETER OF HOBS AND DIE TAPS, AFTER HARDENING.

Diameter of Tap, inches.	Limit of Oversize.	Diameter of Tap, inches.	Limit of Oversize.	Diameter of Tap, inches.	Limit of Oversize.
$\frac{1}{16}$	0.00025	$\frac{7}{8}$	0.002	$2\frac{3}{4}$	0.003
$\frac{1}{8}$	0.0005	1	0.00225	3	0.003
$\frac{1}{4}$	0.00075	$1\frac{1}{4}$	0.00225	$3\frac{1}{4}$	0.0035
$\frac{3}{8}$	0.001	$1\frac{1}{2}$	0.0025	$3\frac{1}{2}$	0.0035
$\frac{1}{2}$	0.00125	$1\frac{3}{4}$	0.0025	$3\frac{3}{4}$	0.004
$\frac{5}{8}$	0.0015	2	0.00275	4	0.004
$\frac{3}{4}$	0.00175	$2\frac{1}{4}$	0.00275	. ..	......

Tapper taps, and machine taps for general purposes, are threaded oversize, before hardening, as follows:

TABLE III. LIMIT OF OVERSIZE OF TAPPER TAPS AND MACHINE TAPS, BEFORE HARDENING.

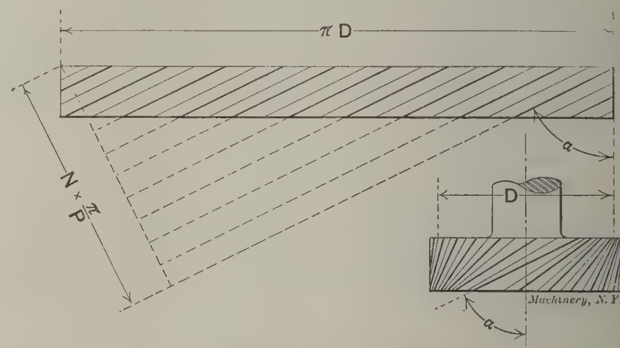
Diam. of Tap, ins.	Limits of Oversize.	Diam. of Tap, ins.	Limits of Oversize.	Diam. of Taps, ins.	Limits of Oversize.
$\frac{1}{4}$	0.0005—0.001	1	0.001 —0.002	$2\frac{1}{2}$	0.002 —0.003
$\frac{1}{2}$	0.001 —0.0015	$1\frac{1}{2}$	0.0015—0.0025	3	0.0025—0.0035
$\frac{3}{4}$	0.001 —0.0015	2	0.002 —0.003	.·.	....

The figures given conform to the actual practice of one of our most prominent tap manufacturers.

SPIRAL GEAR DIMENSIONS.

F. S. L. Through the columns of MACHINERY, can you give me the calculations necessary for cutting two spiral gears of the following proportions; both gears to be 2-inch pitch diameter, 10 diametral pitch, which gives 20 teeth? The ratio is to be 2 to 1.

A.—You are mistaken in your belief that it is possible to have a spiral gear of 2-inch pitch diameter, with 20 teeth of 10 diametral pitch, if by the diametral pitch you mean the pitch of the cutter. Those requirements are all right for a spur gear, but the cutting of the tooth on an angle alters the matter, as you perhaps will understand from the cut. The spiral gear shown has a diameter D, and tooth angle a, with N teeth of P diametral pitch. The plan view above the drawing of the gear represents a development of its circumference at the pitch line. That is to say, it is as if the gear could be neatly pared with a sharp knife at the pitch line, and the resulting peeling straightened out as shown. The length of this peeling or development would evidently be the pitch circumference of the gear, which equals πD, in which, of course, $\pi = 3.1416$. In the development, the teeth have been extended by dotted lines as shown. The width of any given tooth and space combined, measured at right angles to its length, is the normal circumferential pitch of the tooth, which equals $\frac{\pi}{P}$. The entire width, then, of N teeth, laid side by side as shown in the figure, amounts to $N \times \frac{\pi}{P}$. An examination of this sketch will also show that $\pi D \times \cos. a = N \times \frac{\pi}{P}$. Solving this equation in



Spiral Gear Dimensions.

turn for D and P, we have

$$D = \frac{N}{P \times \cos. a} \quad (1) \qquad P = \frac{N}{D \times \cos a} \quad (2)$$

We know that the pitch diameters of our two gears are to be equal; calling one gear a and the other b, and giving the letters in the first formula sub letters to correspond, we have

$$\frac{N_a}{P \times \cos. a_a} = \frac{N_b}{P \times \cos a_b}$$

If one of our gears were to have 20 teeth and if the ratio were to be 2 to 1, then the other gear would have 10 teeth. Substituting 20 and 10 for N_a and N_b, respectively, then reducing, and eliminating P, we have

$$\frac{2}{\cos. a_a} = \frac{1}{\cos. a_b}$$

Remembering that a_a is the complement of a_b, since the shaft angle is 90 degrees, we have (rearranging the equation):

$$2 \sin a_a = \cos. a_a$$

In order, then, to find the proper tooth angle to meet the conditions, we find in a table of sines the angle which has a cosine equal to twice the sine. This angle is found to be 26° 34′, which will be the proper tooth angle for the 20-tooth gear. The angle for the 10-tooth gear will be its complement, or 90° — 26° 34′ = 63° 26′. Using Formula 2 to find the pitch, filling in the letters to agree with the data for gear a, we have

$$P = \frac{20}{2 \times 0.89441} = 11.18$$

which is the diametral pitch of the cutter for the given conditions. The other dimensions required, such as the thickness of the tooth, the length of the spiral, the series number of the cutter required, and so on, can be found by the rules given in the article in the May, 1906, issue of MACHINERY, entitled "A Method of Procedure in the Design of Helical Gears."

We do not know that this solution meets your requirements. It would be possible to keep the center distance between shafts the same, number of teeth the same, but vary the diameters somewhat, making one of the gears larger than the other, and by so doing have the pitch of the cutter 10 exactly; then a stock cutter could be used. Or it would be possible to vary the center distance slightly, keep the gears of equal diameters, 10 and 20 teeth respectively, and be able to use a stock 10-pitch cutter. It is not possible to use a 10-pitch cutter under the conditions you prescribed.

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

ATTACHMENTS FOR BROWN & SHARPE MILLING MACHINES.

The Brown & Sharpe Mfg. Co., of Providence, R. I., has recently completed a series of attachments for its latest line of milling machines. This entire lot of attachments is new in design. They are all so constructed as to be bolted directly on the extended knee slide of the milling machine, this method of attachment being at once rigid and convenient. The list comprises a slotting attachment, rack cutting attachment, indexing attachment for table, high-speed milling attachment, vertical spindle milling attachment, compound vertical spindle attachment and universal milling attachment.

Fig. 1. Vertical Spindle Attachment.

Fig. 2. Compound Vertical Attachment.

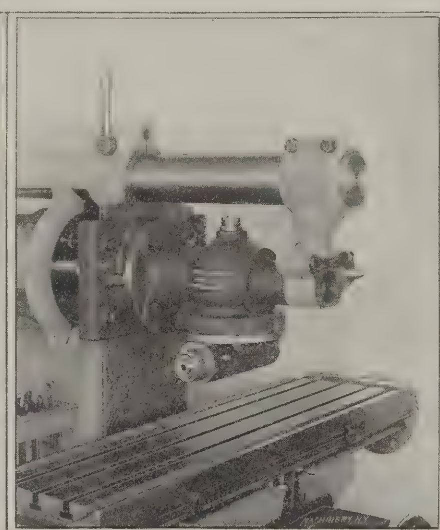


Fig. 3. Universal Milling Attachment.

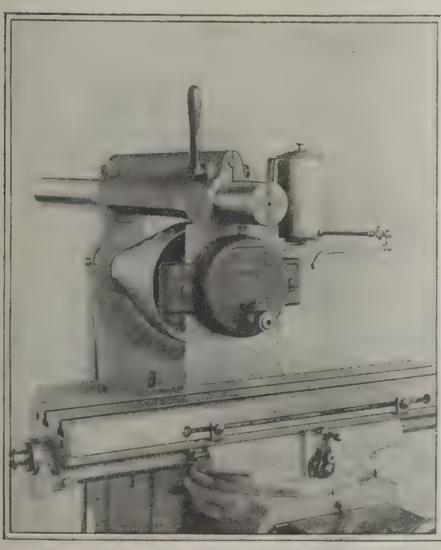


Fig. 4. Device for High-speed Milling.

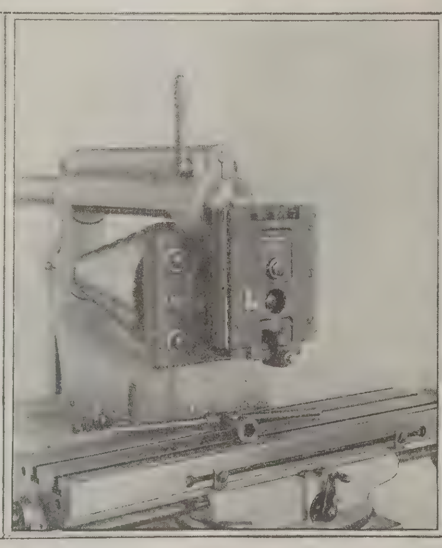


Fig. 5. Slotting Attachment.

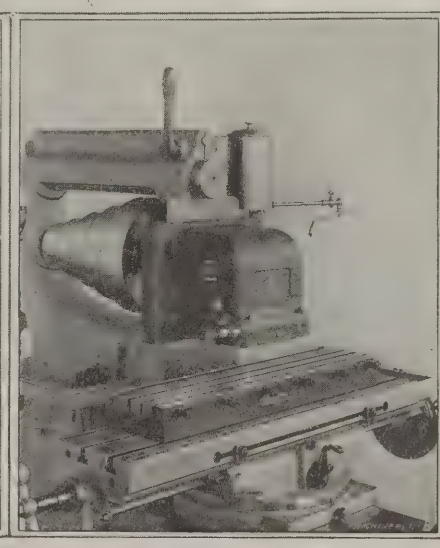


Fig. 6. Rack Cutting Attachment.

Fig. 1 shows the form of vertical spindle milling attachment used on the smaller machines up to the No. 3 heavy plain and universal sizes. The spindle is of steel, ground, and running in bronze boxes provided with means of compensation for wear. It is driven through hardened steel bevel gears. It can be set at any angle from a vertical to a horizontal position, the angle being indicated by graduations on the side of the head, reading to degrees. The spindle is provided with a tapered hole, and is threaded for face milling cutters. A drawing-in bolt is furnished for holding collets, etc., in the spindle. The larger sizes have a groove milled across the end of the spindle for engaging driving tongues on arbors, cutters, etc. The means provided for attaching the device to the front of the column are plainly shown in the cut.

For the milling machines, both plain and universal, larger than the No. 3 heavy size, a modified form of this vertical spindle attachment is used. This was described and illustrated in the new tools column of the June issue of MACHINERY. A still lighter form is used for high-speed vertical milling. This follows the general construction of the firm's original vertical attachments, being clamped to the over-hanging arm, and driven by spiral gears from a keyed arbor in the main spindle.

Fig. 2 shows the compound vertical spindle attachment. It is applicable to a large variety of milling operations, since it can be set to swivel in either of two planes. It is held rigidly in position, the upper part of the head or frame being clamped to the over-hanging arm, while the lower part is fastened by a heavy bracket to the face of the column. The spindle is driven through steel bevel gears, by a horizontal shaft inserted in the main spindle of the machine. The possibility of setting the spindle to an angular position in a plane at right angles to the table is a valuable feature in milling angular strips, table ways, etc., since with this arrangement the full length of the table travel is available, and an ordinary end mill can be used, instead of a special angular cutter.

In Fig. 3 is shown the universal milling attachment. This is clamped to the knee slide on the column at one end, and to the over-hanging arm at the other. It is fully universal, and is applicable to a great variety of work: drilling, milling angular slots or surfaces, cutting spiral gears at any angle, cutting racks, milling key seats, etc. This variety of work is made

possible by the fact that a double swivel is provided. The attachment may be swung bodily about the axis of the machine spindle, and the cutter spindle of the attachment may also be swiveled about an axis at right angles to the first. Both adjustments may be read from graduations, as shown in the cut.

Fig. 4 shows a high-speed milling attachment. This is useful for drilling small holes and driving small end mills. The device is simple in construction, no extra belt or auxiliary device being required for attaching it to the machine. The mechanism is enclosed and protected from dirt and injury. As many speed changes are available as are provided for in the design of the machine itself. The spindle is driven

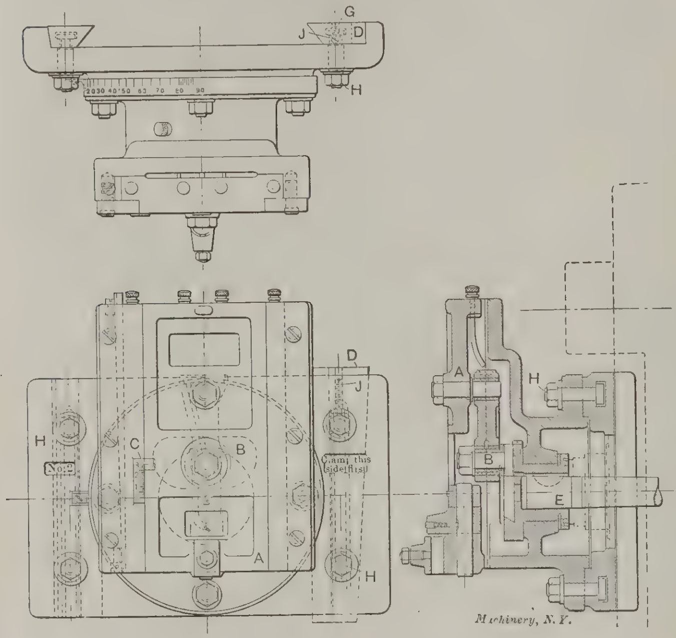


Fig. 7. Details of Slotting Attachment.

by an internal gear, screwed onto the main spindle of the miller, meshing with a pinion on the spindle of the attachment.

The slotting attachment shown in Fig. 5 is unusually well adapted to toolmaking, die sinking and work of a similar character. It is of simple construction, as may be seen from the line cut, Fig. 7. The device is entirely independent of the over-hanging arm, being clamped to the face of the machine column. The tool slide *A* is driven from the main spindle of the machine by an adjustable crank *B*, which allows the stroke to be set at different lengths. These varying lengths are indicated by a graduated scale at *C* on the front of the attachment. The slide swivels about the machine spindle, and can be set at any angle from the vertical to the horizontal without affecting the length of the stroke. The setting is indicated by graduations on the side of the swivel head, reading to ½ degree. The attachment is entirely self-contained, no auxiliary belting being required when mounting it on the machine. An interesting detail in the design is the provision made for allowing for variations in the width of the extended knee slide on the column to which the attachment is clamped. An adjustable gib, *D*, is provided on the right-hand side. This is tapered and fits a tapered bearing in the body of the attachment. It may be adjusted vertically by screw *J* until the spindle *E* of the attachment is exactly in line with the tapered hole in the end of the machine spindle. This vertical adjustment of *D*, of course, shifts the whole attachment horizontally. When it has been thus centered, it may be locked in position by check screws *G*. Then it may be removed and replaced on the same machine indefinitely without further adjustment, the four nuts *H*, on the front, being used for fastening it in place.

The rack cutting attachment, shown in Fig. 6, is particularly adapted to the cutting of racks, and the cutting off of stock, etc. It is fastened to the machine in the same manner as the previous device. All the working parts are entirely enclosed, thus protecting them from dirt and injury. The cutter spindle is hardened and ground, and runs in bronze boxes, of which the one at the front end is provided with means for compensation for wear. It is smoothly and powerfully driven from the main spindle of the machine through hardened steel bevel and spur gears. Special vises are furnished for holding the work. That for the Nos. 1 and 2 sizes has jaws 26 inches long, which will open 3 inches. That for Nos. 3 and 4 attachments has jaws 36 inches long, with an opening of 4 inches. With this rack cutting attachment, a special indexing device is generally used. This consists of a bracket, fastened to the table T-slot at the left-hand end, carrying a locking disk, together with change gears for connecting it to the feed screw. By its use, racks may be cut, and longitudinal settings made, without the necessity for relying on the graduated dial usually employed for the purpose. Change gears are furnished for cutting teeth as follows: The diametral pitches from 3 to 6 by half sizes, all pitches from 7 to 16, and even pitches from 18 to 32 inclusive; and circular pitches 1 inch to 1-16 inch by 1-16 inch. With a few additional gears, the attachment can be used to cut metric racks with an English screw. With machines furnished with the metric screw, the gears give modules of from 1 to 8, and all circular pitches from 2 millimeters to 16 millimeters, inclusive. An index table giving these various settings is furnished.

PLURALITY DIE BOLT CUTTER.

The principal feature of this machine, made by the Mummert, Wolf & Dixon Co. of Hanover, Pa., is the die. The front elevation of the machine is shown in Fig. 1, while the die head will be more clearly understood from an inspection of Figs. 2 and 3, where the dies used are shown both in place in the head and dismounted. These three dies or chasers have, as shown, twelve cutting points each, and they may be indexed to bring any one of the cutting edges into working position, so that twelve sizes of thread may be cut without changing the tools. With this arrangement all the varieties of threads commonly used can be cut with one or two set of dies, it not being necessary to have a large number of loose parts as is the case with the ordinary construction.

The head is simple in construction, as may be seen in the sectional view, Fig. 4. The dies are held firmly by tempered tool steel studs with notched heads at the back, engaging locating disks having notches corresponding with points on

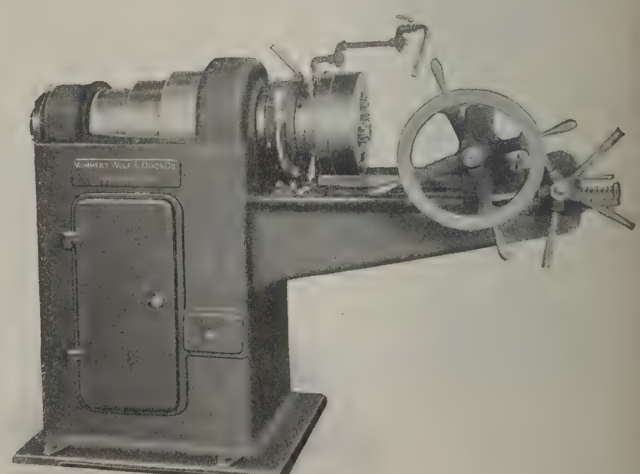


Fig. 1. Bolt Cutter with a Plurality of Dies Instantly Available.

the dies. These provide means for locating the points when changing from one size to another. It is not necessary to remove the dies in changing the adjustment. The partly countersunk nut on the front of each die, shown in Fig. 2, is loosened and the stud is pushed back, thus disengaging the connection between the locating disk and the bolt. The die can then be turned until the guiding surface wanted points toward the center. The spring then pushes the stud forward into place and the nut is again tightened. This can all be done very quickly. The dies can be adjusted while the machine is running by turning the four-handle adjusting

ring back of the head. This ring is graduated so that the amount of the adjustment is easily obtained. The machine has a simple, positive automatic throw-out. Arrangements for automatically closing the dies are also provided for, and are furnished when desired.

There is no gearing exposed in this machine. As shown in Fig. 4, the back gearing is suspended beneath the cone pulley in the main casing. The front bearing is long and close up to the head. The part of the spindle running in this bearing is provided with means for taking up the wear. The oiling system and the means provided for disposing of the chips are also clearly shown in this cut. The oil pump works properly when run in either direction, so that it is not necessary to change the belt when cutting left-hand threads. The construction of the vise and carriage is clearly shown in Fig. 1.

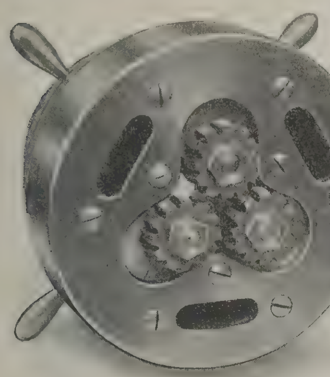


Fig. 2. Front View of Opening Head, with Cutter Mounted in Place.

The die system used presents a number of advantages.

Fig. 3. Multiple-faced Cutters.

Fewer parts are necessary to cover a wide range of sizes. The dies may be arranged to have fewer points, or the sizes most used may be duplicated. The dies are made so that all points of the same size are interchangeable with each other on the same set of dies, or any point of the same size will

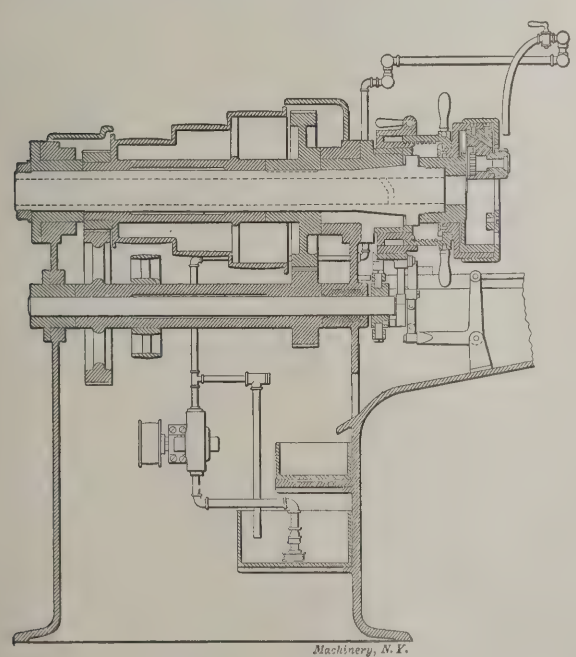


Fig. 4. Sectional View of Mechanism of Bolt Cutter.

interchange on the same number die of any other set. Thus, if the working edge of one die of a set should be broken or be worn out, the remaining two cutting edges on the other dies may be used with another cutting edge of the same size on the same die, or any other die of the same number. Three dies constitute a set. By using three dies the stock is more readily held central, so that one die cuts just as much as another. The dies can be easily sharpened, the same as ordinary chasers, by grinding with a V-shaped wheel. The machine is fully covered with patents and pending applications.

MUELLER FOUR-FOOT STANDARD RADIAL DRILL.

The Mueller Machine Tool Co. of Cincinnati, Ohio, has recently perfected the radial drill shown in the accompanying half-tone. Aside from the constructional features which give it the stiffness and driving power required for tools to work under modern shop conditions, the machine is interesting in the means provided for changing the speeds and feeds. Twenty-four changes of speed are given to the spindle, and eight changes of automatic feed for each spindle speed. Any one of these spindle speeds may be instantly obtained while the driving belt is in motion, without noise or shock, and all of them are absolutely positive.

The two long levers shown in front of the speed box control four changes, the small locking lever shown between the two preventing the possibility of more than one speed being engaged at a time. In Fig. 2 is a diagram of the speed box, gearing shafts, and friction clutches. The latter are operated by the two long levers just mentioned, and connect the driving shaft with either one of the four gears *A*, *B*, *C* and *H*.

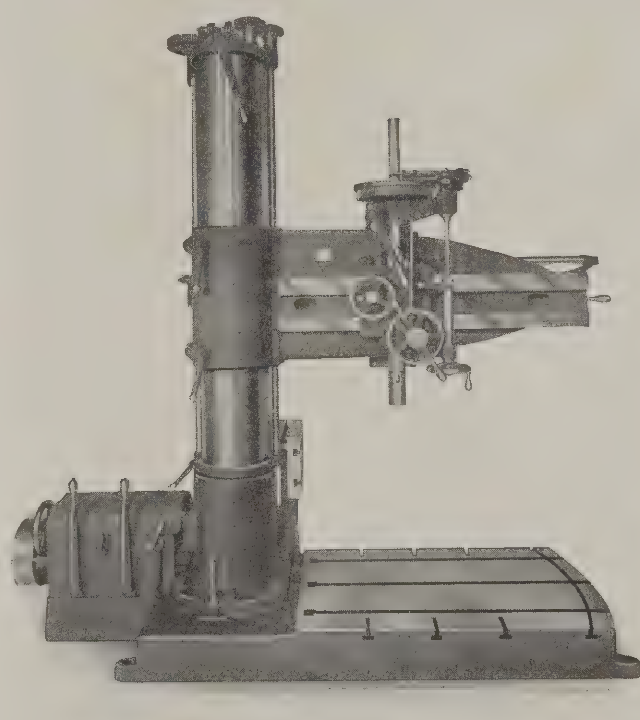


Fig. 1. Mueller Radial Drill.

These gears mesh respectively with A_1, B_1, C_1 and *D* on the intermediate shaft, which may thus be driven at any one of four different speeds, depending on which friction clutch is engaged. The small lever on the right side of the speed box is used to bring gears D_1, E_1 and F_1, which slide on the upper shaft of the speed box, in mesh with the corresponding gears *D E F* fixed on the intermediate shaft. Three more changes of speed are thus obtained, which, multiplied by those on the first driving shaft obtained by the clutches, give twelve changes of speed; this number is doubled by the back gears located on top of the column, giving twenty-four changes in all. The latter gears are shifted by the lever shown at the base of the column. This lever is also used to bring the gear on the center shaft in mesh with the gear on the elevating screw, when this is required. When the elevating screw is to be reversed for lowering the arm, gears D_1 and *G* in Fig. 2 are brought into mesh, causing the upper shaft in the speed box to run in a reverse direction at an increased speed.

The column is stationary, made in one piece, and has a heavy section throughout. It is bolted to the base and does not revolve. It has four webs extending its entire length,

adding to the strength of the machine, and serving to resist heavy strains at any height, particularly when the arm and spindle are at their maximum travel. The arm is of cylindrical section with its upper brace as close to the head as possible. The lower brace is at the outer edge. This construction prevents twisting of the arm, while resisting upward pressure due to the thrust of the drill. A top cap on the column, resting on roller bearings, supports the arm, which is able to make a full circle about the column if necessary. It is instantly locked by fixed binding levers. The arm is lowered at almost three times the elevating speed, by a screw having ball thrust bearings.

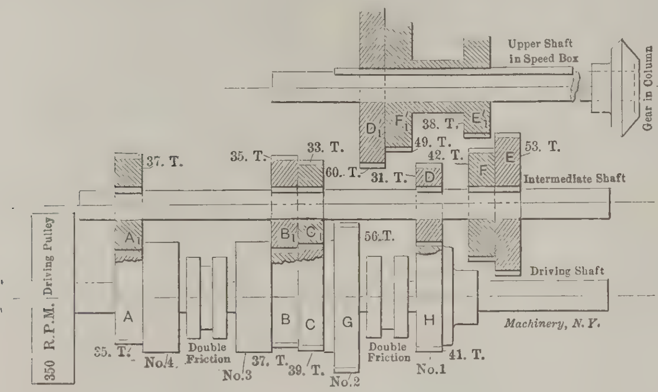


Fig. 2. Arrangement of Clutches and Gearing in the Speed Changing Mechanism.

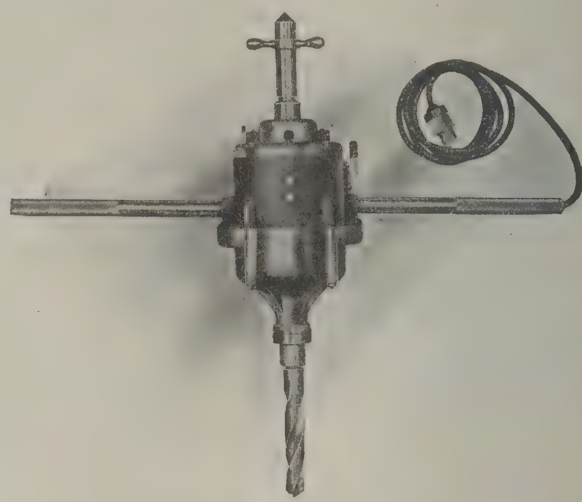
The spindle is made of crucible steel, carefully ground. It is counterbalanced, has quick advance and return, and its bearings have provision for taking up wear. It is started, stopped and reversed for tapping by the long lever shown in front of the head, which operates two self-adjusting noiseless friction clutches, located at the back of the head. When used for tapping it is impossible to accidentally engage either the automatic or the lever feed, so that the breaking of taps from this cause is avoided. An adjustable gage nut causes the spindle to slip when the tap reaches the bottom of the hole.

The feed used is similar to that described in the January, 1906, issue of MACHINERY. It provides for a positive feed, quickly changed while the spindle is in motion. This may be used for high-speed drills and reamers. When a friction feed is desirable, the operator can easily make the change from one to another by turning a single nut. An automatic trip to this feed is provided, which has a safety stop to prevent the feeding of the spindle after it reaches the limit of its travel. A graduated bar on the counterbalance weight is set to zero when the drill enters the work. The bar has several adjustable dogs to trip the feed as often as desired. These do not interfere with the spindle travel. The feed can also be tripped by a lever on the vertical feed rod.

HISEY PORTABLE ELECTRICAL SCREW FEED DRILL.

The motor for this drill, which is made by The Hisey-Wolf Machine Co., Cincinnati, Ohio, is entirely enclosed at the spindle end, so that borings and chips of metal and wood are prevented from entering the casing and interfering with the action of the gears and commutator. The gears and other working parts are hardened. All the parts are easily accessible for adjustment, though fully protected from accident. The tool is simple and compact, with no complicated parts to get out of order, and is especially built for the heavy work it is intended to perform. The switch is located on the body of the motor, within immediate reach of the operator. The two side handles are detachable. An "old man" is furnished as an extra, if desired.

These portable electric drills are particularly useful in machine shops, boiler plants, bridge building, construction work, and ship yards. They can be carried anywhere, as any length of lamp cord can be attached. This style is made in two sizes: the ⅞-inch size with a weight of 27 pounds, and the 1¼-inch size with a weight of 38 pounds. The figures given refer to the diameter of hole it is possible to drill

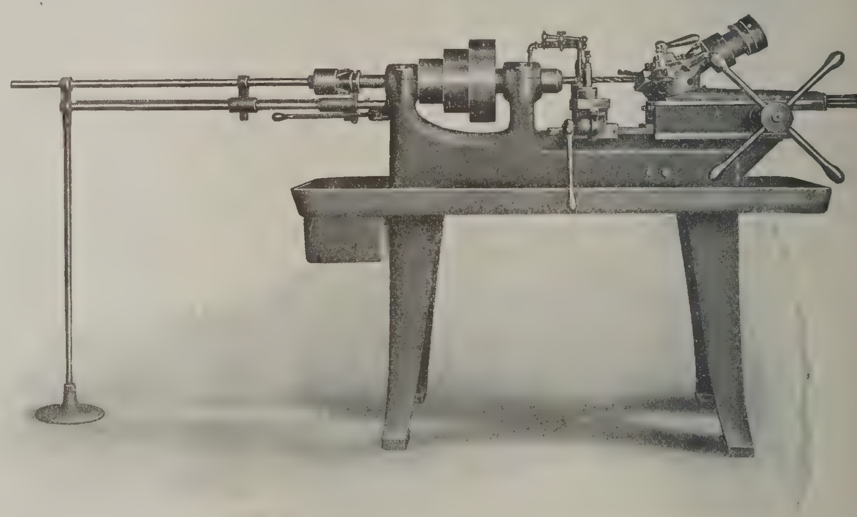


Electrical Drill for Heavy Work.

in steel with the tool; larger sized holes can be made in softer material. Hand drills in smaller sizes, and Scotch drills up to 2 inches capacity, are also made by the same firm.

THE "TILTED TURRET" LATHE.

This machine has been designed to meet the demand for a screw machine or monitor lathe whose turret will carry tools of sufficient diameter to properly handle the work, and also allowing short box tools to be bolted to the faces of the turret, and still permit a long piece to be machined.



The "Tilted Turret" Lathe.

The general design of the machine is shown in the accompanying cut. It is equipped with wire feed. The bearings are self-oiling, and one filling of the chamber under the bearing will lubricate the machine for a year. The turret is hexagonal and is fitted with holes and binder bushings for round-shank tools, and has its faces square with the spindle for attaching tools. It is mounted on a slide rest at an angle of 15 degrees with the horizontal. By this arrangement a tool, when swung over the turret slide, is set at an angle of 30 degrees with the horizontal, thereby permitting the use of a tool two or three times the diameter possible on other styles of turret lathes. Another great advantage of this machine, a feature which is found in no other, lies in the lower row of holes in the turret.

It will be noted from the accompanying cut that the work is arranged to pass directly through the turret and back over the turret slide without interfering in any way with the tool which might be in the back hole or fastened to the rear face. This feature is a very important one, as long stock may be handled without necessitating a tool with an excessive

overhang. It will be further noted that the pressure on the turret is taken up directly on the turret slide, which comes nearly on a line with the center of the spindle, in this manner relieving the center post of the turret from undue strain and consequent springing.

Each hole of the turret has an independent stop, shown at the rear of the turret slide; and by a new construction these stops are stationary and do not revolve with the turret. The turret slide and saddle have gibs for adjustment, both vertically and crosswise, to take up wear and preserve the turret alignment.

The oil-pan is large and has a tank cast in the head-stock end with a pump to force the oil to the work. A double cut-off rest is provided, having an extra long bearing on the bed with an adjustable gib. The countershaft is of the rim friction type, and the friction clutch has but four working parts. Both pulleys and bearings are self-oiling and can be operated for six months steadily without attention.

The machine, as shown, takes 1-inch stock through the wire feed, and other sizes are now under process of construction at the factory. It is made by the Wood Turret Machine Co., of Terre Haute, Ind., and is being put on the market by Hill, Clarke & Co., Inc., 156 Oliver St., Boston.

THE FARWELL QUICK-CHANGE HAND MILLING MACHINE.

The interesting series of half-tones shown with this article illustrate the wide variety of work which can be conveniently taken care of by the hand milling machine shown in Fig. 1.

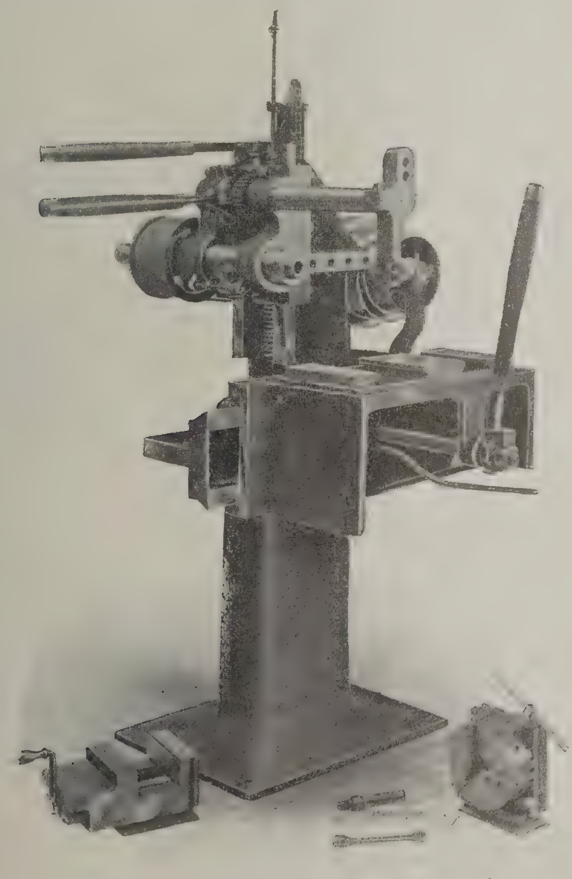


Fig. 1. Farwell Quick Change Hand Miller.

This is known as the Farwell "quick-change" hand milling machine, and is built by The Adams Co., of Dubuque, Iowa. It will be seen to differ radically in construction from most other machines of its kind. For instance, the cross travel is secured by the endwise movement of a quill carrying the spindle, operated by the upper of the two levers on the column, while the vertical travel is provided for by the sliding of the spindle head vertically on the main casting. This arrangement makes it possible to have but one sliding surface (that for the transverse movement) between the work table and the main frame of the machine, instead of the three surfaces usually necessary, and the rigidity thus obtained makes it possible to do heavier work than ordinarily attempted on hand machines. The use of high-speed milling cutters still further increases the range of the tool. With the old carbon steel cutters, when the tooth contact was comparatively slow, power feeds were required to get the slow, steady movement necessary to produce true smooth surfaces, but when high-speed cutters are used, with the tooth contact nearly quadrupled, the surface produced by hand-fed mechanism is satisfactory, while the rapidity of operation, particularly on short cuts, is greatly increased.

The spindle is driven from a 3-step cone, connected to the slide by an adjusting rod for preserving the proper belt tension; with the two-speed countershaft provided, this gives six changes of spindle speed. As shown, an overhanging arm is provided, carrying an arbor support on the outer end. This support may be removed and the arm pushed back out of the way when it is not needed. Provision is made at the other end of the arm for holding studs for former rolls to use in profiling, cam cutting, etc. For the same purpose, a bracket is provided, extending rearwardly from the front end of the spindle slide, in which guide pins or rolls may be held at distances of 4, 6, 8 and 10 inches from the spindle. The way in which these provisions are made use of will be described later. The head is provided with adjustable stops for limiting the vertical motion in either direction, and is counterbalanced by weights inside the column. These weights may be added to or diminished, in the same way as is done with scale weights, so that the head may be over-balanced to feed upward, under-balanced to feed downward, or left in equilibrium for hand feeding.

The machine gets the name "quick-change" from the arrangements provided for quickly locking and unlocking the various adjustments, relocating the positions of the levers, and changing the various fixtures provided. The three levers shown, controlling the cross, vertical and transverse movements, respectively, are all connected to similar mechanisms, so that when any one of them is given a movement at right angles to the feeding movement, its slide is tightly locked. This operation at the same time disengages the lever from the shaft of the pinion controlling the movement, so that it may be freely swung to a new position if desired. This is a great convenience in profiling, or when feeding in two directions. By this means the table may be locked, the cutter fed into the work to the proper depth, and the spindle head locked in turn, after which the table may be released and the longitudinal feed begun, all without the use of wrenches, or without requiring the operator to remove his hand from either of the levers.

Two fixtures are regularly provided—the vise and the indexing chuck shown on the floor near the machine. Special provision is made in the design of the table for holding these. In addition to a ⅝-inch T-slot, the table is provided with two clamps, operated by levers beneath it. The chuck, vise, or other fixture is provided with ways which slide in between these clamps, so that it may be secured in any position by a single turn of the lever.

The vise furnished with the machine has jaws 6 inches wide, 2 inches deep, and opening 3 inches in the normal position. By reversing the sliding jaw, as shown in Fig. 4, the vise will hold work 6 inches wide. It is exceedingly heavy and provided with engaging flanges so that it may be secured in the quick-changing clamps in two vertical, as well as in two horizontal positions. The three-jawed chuck furnished is 6 inches in diameter, has two sets of jaws, and will take 1 9-16-inch stock through the center. It is mounted on a heavy angle plate, which may be secured by the quick-acting clamps to the table in one horizontal and two vertical positions. Twenty-four stops or graduations are provided which are convenient in spacing cutters, laying out keyways on quarters or opposite sides of the shaft, or for squaring or milling hexagon heads. It may be used conveniently for circular milling, as well, as shown in Figs. 5 and 6.

In Figs. 2 to 10, inclusive, are shown a number of operations, giving some idea of the varying range of work for which the machine can be used. In Fig. 2 is shown a delicate milling operation with a fine cutter on a comparatively large casting. Work of this kind is easily performed on this machine, since the sensitiveness of the hand feed in vertical

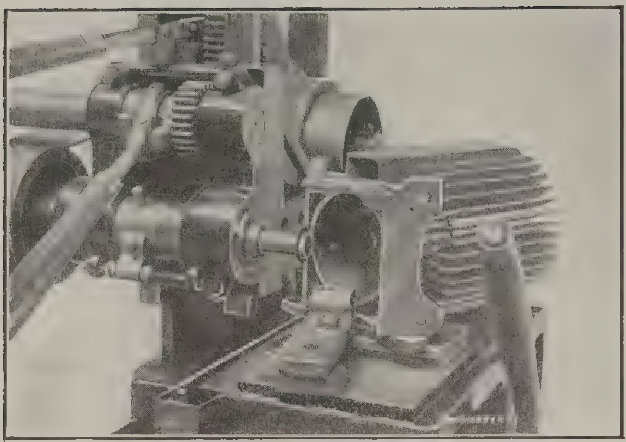


Fig. 2. A Small Cutter Working on a Cylinder Casting.

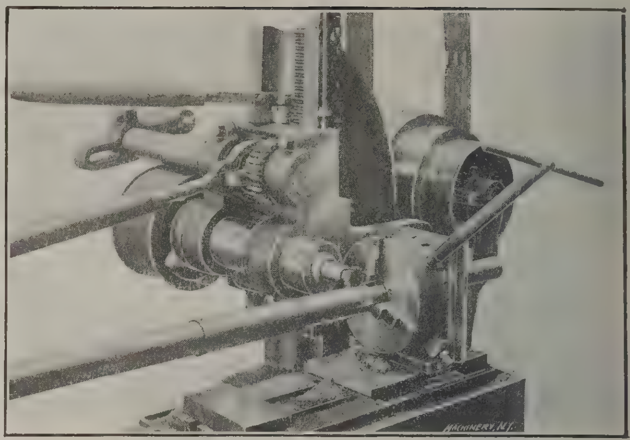


Fig. 3. Quartering Keyways in the Indexing Chuck.

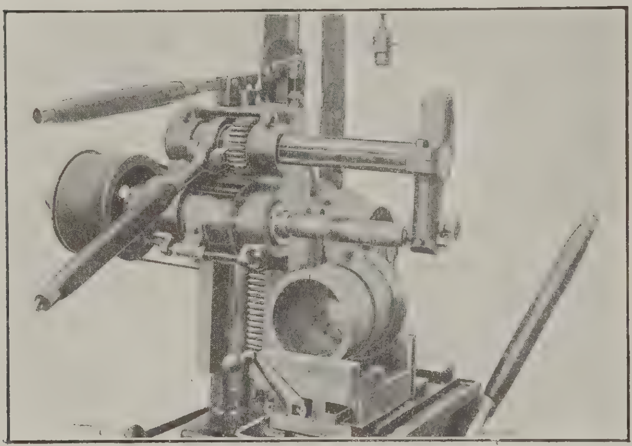


Fig. 4. Vise, with Jaw Reversed to Increase Capacity.

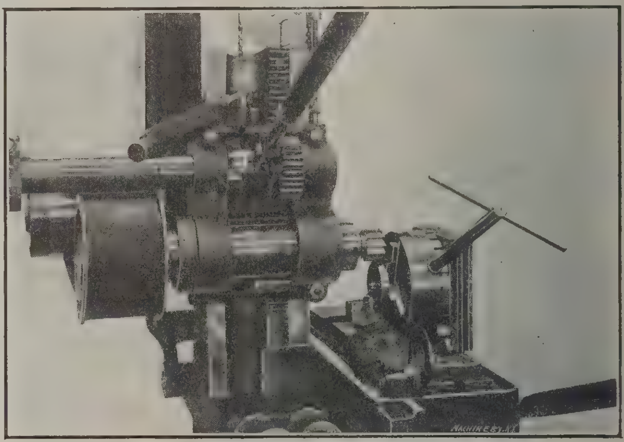


Fig. 5. Circular Milling with Rotating Vise.

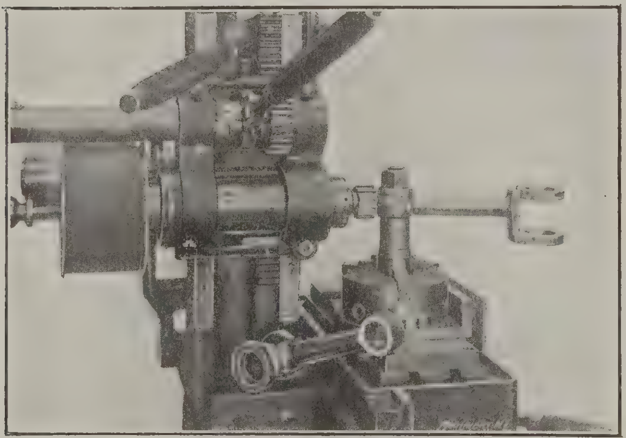


Fig. 6. Another Case of Circular Milling, with End Mill.

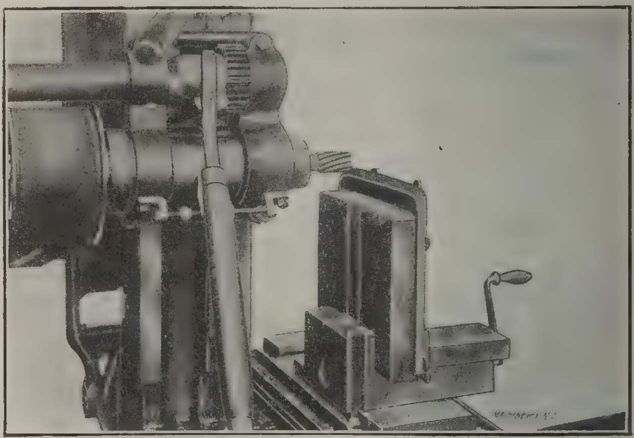


Fig. 7. Long Cuts in Two Directions, Performed in One Operation.

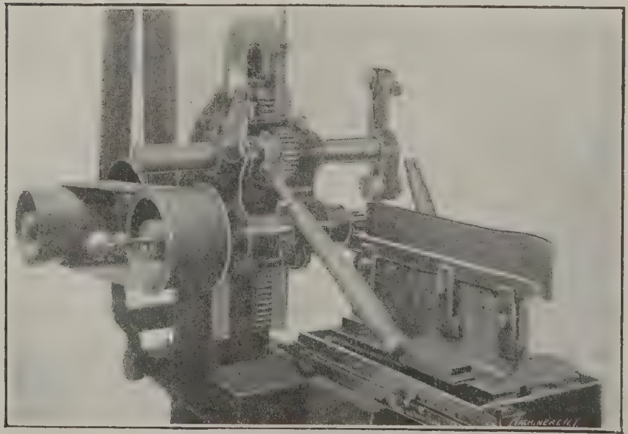


Fig. 8. A Profiling Job.

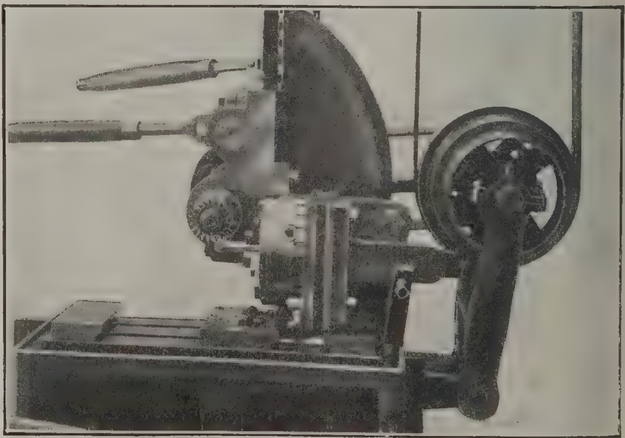


Fig. 9. Cutting a Ball-shaped Mill.

movements is preserved, no matter what the weight of the work may be, the vertical feed being obtained by the travel of the head instead of the work. In Fig. 3 the chuck is shown holding a shaft which is having keyways milled in it at positions 90 degrees apart; the same attachment is also shown in Figs. 5, 6 and 9. In Fig. 4 the vise is shown with the sliding jaw reversed to increase its capacity; the method of holding the vise to the table, previously described, is plainly seen in this cut and in Fig. 7.

Examples of circular milling are shown in Figs. 5 and 6. In the first of these the axis of rotation is horizontal, and parallel to that of the spindle. The chuck holding the work is rotated by a suitable handle, inserted in the socket provided for it, as shown later in Fig. 10. In Fig. 6 an end milling cutter is used to finish the outside of the hub of the

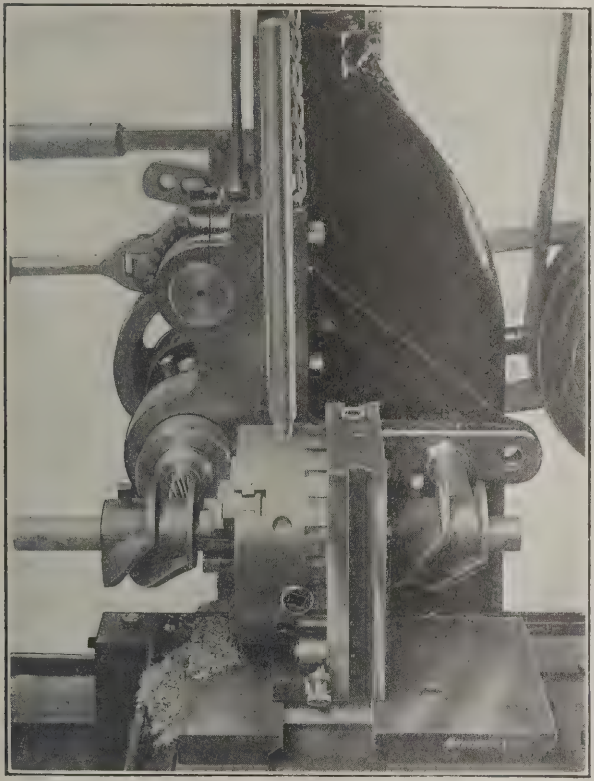


Fig. 10. Cam Cutting with Master Cam and Follower Roll.

link shown. Here the work itself is of such shape that it can be conveniently grasped by the hand of the operator and fed past the cutter.

In Fig. 7 is shown a piece of work in which there are both longitudinal and vertical feeds, each of them of some length. A piece of work of this kind well shows the advantages of the lever mechanism used on the machine, since it requires feeds beyond the range of a single movement of the lever, and requires a change in the direction of the feed from one lever to the other. These numerous changes in adjustments are all accomplished without requiring the workman to remove his hands from the work levers controlling the two feeds.

In Figs. 8, 9 and 10 are shown some suggestive cam-cutting and profiling operations. The first of these shows a bar being milled to the proper contour for a machine handle. A stud with a copying roller is clamped in the overhanging arm; this roller bears on a former held in a fixture clamped to the work table. This fixture is held by the same means as is provided for the chuck and vise. The spindle head has a large part, if not all, of its counterbalancing removed, so that its weight is effective in keeping the copying roller down on the former. As the table is fed along by the lever controlling it, it will be seen that the work is profiled to agree with the former. In Fig. 9 a round-ended mill is being made. This is also a profiling operation. In this case a bracket carrying the former is bolted to the back side of the base of the three-jawed chuck. The copying roller is held on a stud in one of the holes in the bracket attached to the spindle head, as previously described. As in Fig. 8, the unbalanced weight of the spindle head keeps the roll in contact with the former, thus guiding the cutter to form the ball-shaped end of the mill which is being made.

In Fig. 10 the machine is shown at work on a cam-cutting operation. The former and the cam to be cut are each fastened to a shaft passing through the three-jawed chuck, which is held in the same way as in Fig. 9. In this case also the former roll is mounted on the bracket extending backward from the spindle head. This head is locked, however. The cam and the former are rotated by the long handle shown inserted in the periphery of the chuck. As the work is thus slowly revolved, the action of the roll and the former shifts the table backward and forward in such a way as to duplicate the curves of the master cam on the cam being cut.

The table of this machine has a working surface of 18 inches. The length of the table feed is 18 inches, the vertical movement of the spindle head is 12 inches, and the longitudinal movement of the spindle is 2½ inches. The spindle is bored to No. 9 B. & S. taper. The spindle bearings are of bronze. The spindle pulley is 6 inches in diameter and 4 inches face, and the spindle, by the mechanism described, may be given six changes of speed, ranging from 70 to 250 revolutions per minute. The net weight of the machine is 1,090 pounds.

THE JOHNSTON CRUDE OIL ENGINE.

The Johnston crude oil engine, shown in Figs. 1, 2 and 3, operates on a cycle somewhat similar to that of the Diesel engine, but is without its disadvantages. The compression pressure usually carried is 150 pounds per square inch, but any compression from 90 to 300 or 400 pounds may be used if so desired. The fuel is injected in a spray at the end of the compression stroke, and is immediately ignited and burned as it enters the cylinder. The ignition is independent of the compression, and is caused by a plate of special alloy fastened to the end of the piston; this plate is maintained at a high temperature by the recurrent charges of oil burning in the cylinder. The first few charges are ignited by a hot thimble, which is heated externally for two or three minutes before starting the engine. When the engine is once started, no further heating is required.

The oil is broken up by means of a specially designed spraying device and compressed air. A two-stage air-pump is attached to the engine, which maintains the air pressure at any desired point, usually 300 to 400 pounds. Storage tanks are supplied with the engine, and compressed air is used for starting, the start without cranking being certain when instructions are followed. The governor acts on the oil-pump and controls the amount of oil injected into the cylinder each working stroke. As the compression pressure remains practically constant under all loads, the economy, when running light, is much better than in the ordinary throttling gas engines.

One of the principal reasons for the success of this engine is the use of a "hot" combustion chamber. Inasmuch as no air is mixed with the fuel charge until the proper time for ignition has arrived, it is impossible for pre-ignition to take place. Hence there is no limit to the cylinder temperature or compression, so far as pre-ignition is concerned. This is an important feature of economy, as high working temperatures are possible—temperatures that are impossible in explosive charge engines. These, in fact, have to waste a large percentage of their heat in waterjackets designed to keep the cylinder walls below the igniting point of the charge. The Johnston engine is so constructed that during the injection and burning of the oil and the early part of the expansion stroke no water-jacketed surfaces are exposed to the charge. The whole interior of the combustion chamber is at such a high temperature that there is no tendency for tar or carbon to accumulate, and after a long run the interior of the combustion chamber will be found perfectly clean, more so, in fact, than if the engine had been run only a few minutes. In very short runs, the temperature does not rise high enough to burn the walls perfectly clean, but even on no load there is no accumulation of carbon.

The question which immediately springs up in the mind of the engineer when hot cylinders are mentioned, is: "What

about the lubrication?" By referring to the section, Fig. 3, the method of providing hot surfaces for the combustion chamber and cool surfaces for the piston and piston rings may be seen. The piston proper works in a water-jacketed cylinder in the usual way, but the piston is constructed with an extension which is 1-16 inch smaller in diameter than the bore of the cylinder, and hence never comes into contact with it. No matter how hot the piston extension may become,

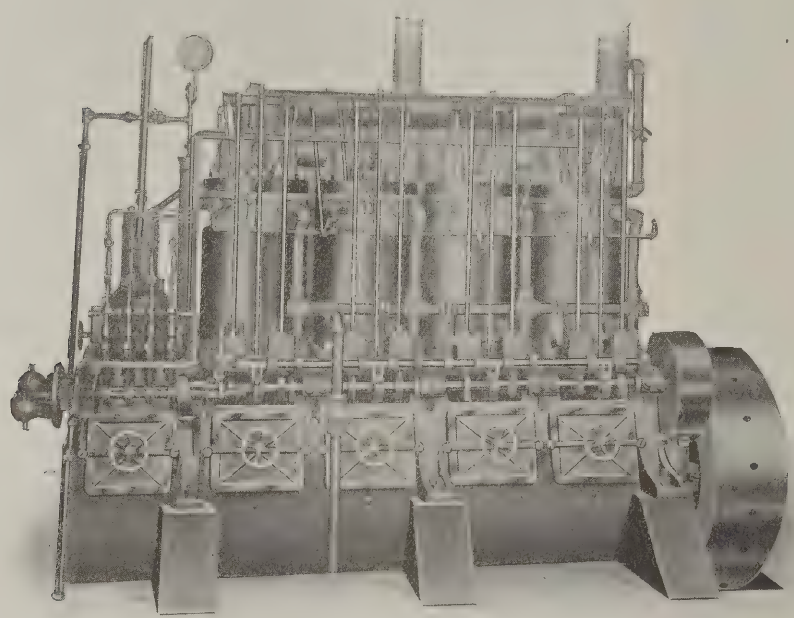


Fig. 1. Johnston 200 H.P Crude Oil Engine.

no harm can result, as there is no contact or friction between the hot parts. The small ignition plate is the only part that deteriorates, this having to be renewed in from six to twelve months.

Samples of every obtainable oil have been tried in this engine, including many grades of crude oil, crude residues, coal oil, gasoline and benzine, without showing any signs of clogging with any grade of fuel. No adjustments whatever are necessary in changing from one fuel to another. A 9 x 12-inch engine has supplied power for the factory of the company for over a year, using the cheapest grade of crude fuel oil, having an average specific gravity of 0.875 and a flash point 170 degrees F. The fuel consumption in small engines, say of 15 H. P., is ¾ gallon of any kind of oil per 10 horse-power hours, at normal load.

This engine is the invention of H. Addison Johnston, and is built by the Johnston Oil Engine Co., Ltd., Toronto, Canada.

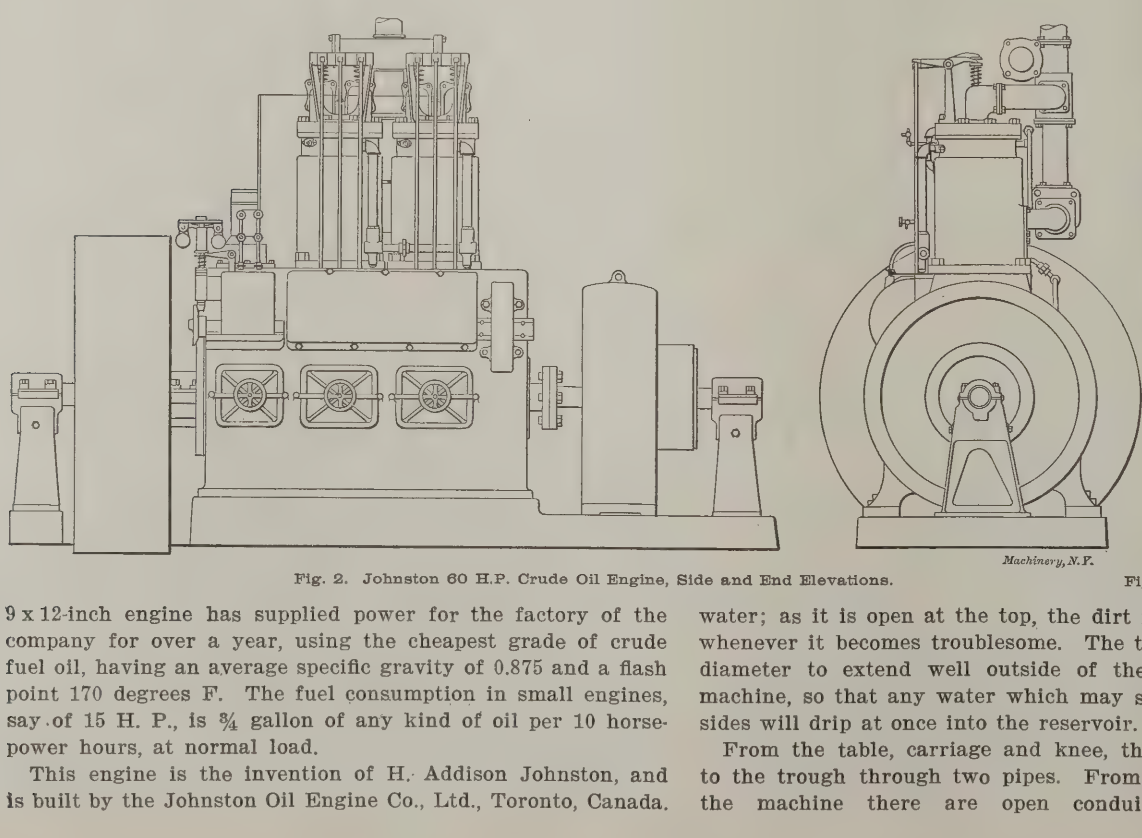


Fig. 2. Johnston 60 H.P. Crude Oil Engine, Side and End Elevations.

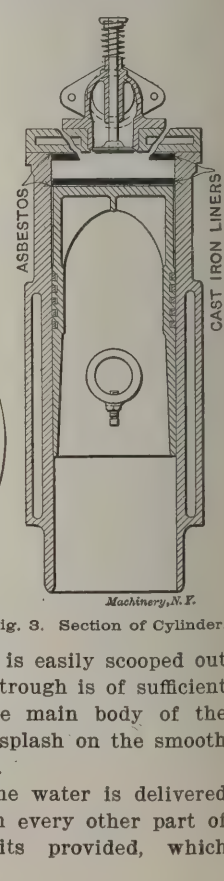


Fig. 3. Section of Cylinder.

IMPROVED THOMPSON UNIVERSAL GRINDER.

In the September, 1906, issue of Machinery we illustrated a universal grinder built by the Thompson Grinder Co., Springfield, Ohio. As will be remembered, one of the interesting features of the machine is the method used to bring the parts into the proper positions to perform work of varying character. The wheel spindle is permanently mounted on a central column, rigidly connected with the base. Around this is a heavy sleeve carrying the knee saddle and work table, with all the mechanisms and attachments necessary for performing widely diversified operations. This sleeve, with all its attached parts, can be rotated around the machine, through an angle somewhat greater than 180 degrees, thus presenting the work either to the face or the edge of either of the two wheels used, or at an angular position with them. A number of improvements have recently been made in this machine, so that it now has the appearance shown in the accompanying half-tone.

The task of devising suitable means for applying a copious supply of water, with the great variety of work of which this grinder is capable, is a difficult one. The successful solution of the problem involved a consideration of the means of delivery of the water and its application, complete drainage of the water from the work and the surface of the machine, freedom of the drainage system and pump from being clogged with sand, ease of access to all parts of the tank and drainage system for the removal of sediment, and, finally, full protection to the journals and gearing. The centrifugal pump has been found to be best adapted to work of this kind, and is therefore used. It is simple in construction, easily accessible, and of such capacity that it does not need to be run at an excessive speed. This pump is placed in a pocket which forms the lowest point in a trough, cast on the base of the machine and completely encircling it. This trough receives the water in any position of the work and table, and forms a depository for the sediment contained in the water; as it is open at the top, the dirt is easily scooped out whenever it becomes troublesome. The trough is of sufficient diameter to extend well outside of the main body of the machine, so that any water which may splash on the smooth sides will drip at once into the reservoir.

From the table, carriage and knee, the water is delivered to the trough through two pipes. From every other part of the machine there are open conduits provided, which

remove all possibility of the drainage system becoming clogged. Since it is useless to try to confine the water exactly to the point where the wheel touches the work, the plan has been adopted of providing for perfect drainage, rather than to try to restrain the flow of the water. The adoption of this principle has necessitated the location of all journals and gears below water-tight decks. The top of the knee casting is solid, and forms a water shed from which lead the two drip pipes shown opening into the trough. There are no other openings in the top of the knee casting, so that the gearing, which is located within, is protected not only from water, but from grit and dust. The carriage is entirely closed beneath, so that no water can splash from the top of the knee into the enclosed gearing. Where the casting rests on the ways of the knee, projecting lips are provided which prevent water from entering the bearing surface. So well is the drainage system worked out that if the machine were set out in a rain storm, practically all the water striking it would flow at once into the trough, while all journals and gearing would remain perfectly dry.

Improved Thompson Universal Grinder.

A single lever serves to start, stop and reverse the table feed. This lever is seen in the center of the carriage on the top, within easy reach at all times. The hand-wheels for cross and longitudinal adjustments and for elevating the knee are graduated to indicate movements of 0.001 inch.

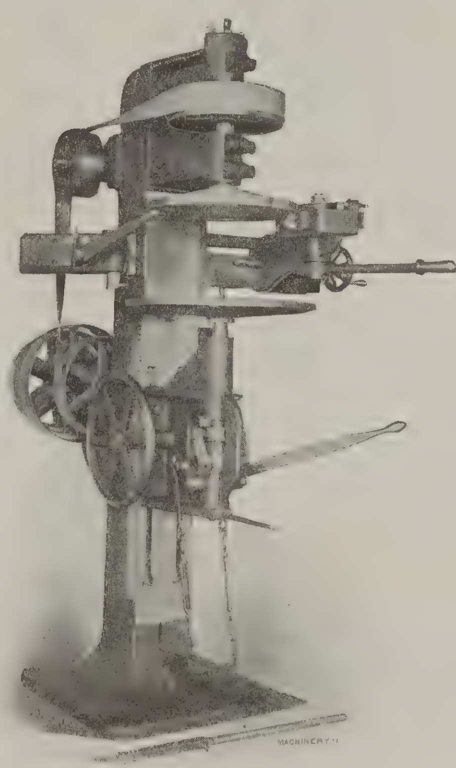
The capacity of the machine will be indicated by the following figures. It will take in between the centers, either 10 or 20 inches in diameter, by 36 inches long. It will grind knives 48 feet in length. The capacity for surface grinding is 8 inches wide by 42 inches long. The cutter grinder attachment provides for work up to 28 inches in diameter. Internal grinding up to 30 inches in diameter and 4 inches in depth is practicable; a special head-stock is used for internal grinding of larger diameters. The makers believe that the variety and dimensional range of the work performed is unapproached by any other similar machine.

BLISS DOUBLE SEAMING MACHINE.

The double seaming machine shown in the accompanying halftone has been recently designed by the E. W. Bliss Co., of 5 Adams St., Brooklyn, N. Y. It is especially designed for use in connection with the manufacture of articles of iron and enamel ware, where the shape of the part to be manufactured is round, as is the case with foot tubs, wash tubs, buckets, and similar articles. One of the improvements introduced is the toggle motion by which the treadle is connected with the bottom or clamping plate. When the treadle is depressed, the toggles are locked and form a positive clamp between the chuck and body, thus allowing the operator to remove his foot from the pedal. At the conclusion of the operation of double seaming the pressure is removed by touching a handle at the right side of the machine, after which the bottom plate drops to its lower position, allowing the article to be taken off and another one to be placed in position to be worked on.

Another point of interest is the smoothing attachment on the left-hand side. In many articles the top edge of the body is wired, and difficulty is often experienced, especially on tapering work, in getting the metal to hug the wire ring closely all the way around. With this attachment it is possible, while performing the double seaming operation at the bottom, to smooth out all the wrinkles formed in the process of wiring, and roll the metal closely over the wire. This adds greatly to the appearance of the finished product without taking any more time.

The adjustments are all easy of access and quickly made. In changing the machine for different heights of bodies, use is made of the rack and pinion seen on the left-hand side of the machine. The adjustments for different diameters of work and depth of seam are made by suitable screws and hand-wheels. One of these can be seen at the back of the arm which carries the double seaming roll; the other, for adjusting the machine for different heights of seam, is out of sight in the cut. The machine will take work up to 26 inches in diameter and 36 inches in height. It weighs about 3,000 pounds.



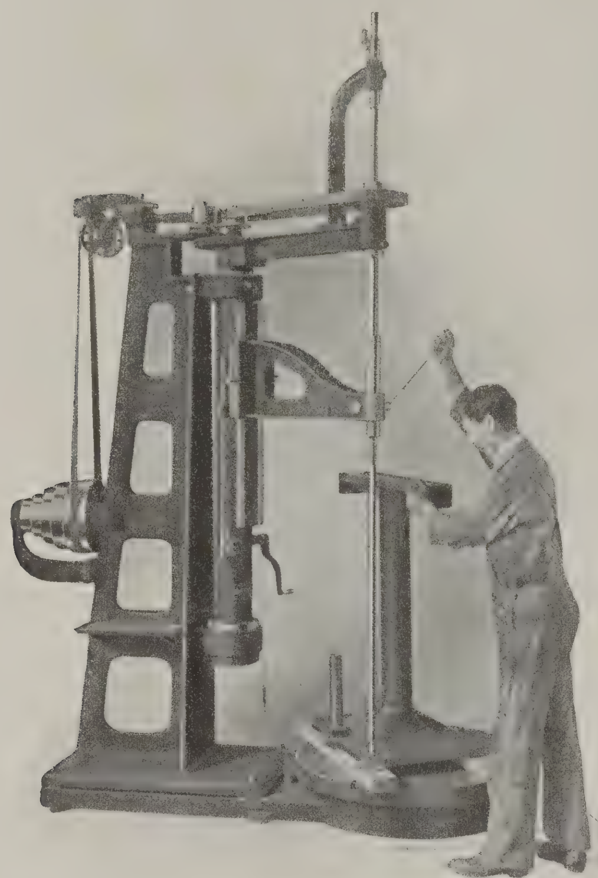
Double Seaming Machine with Smoothing Attachment for Wired Edges.

HENRY & WRIGHT SENSITIVE RADIAL DRILL.

The machine shown in the accompanying halftone, built by The Henry & Wright Mfg. Co., Hartford, Conn., is somewhat unusual in that it is an application of the sensitive drill-press idea to the radial type of machine. The builders believe that there is a large amount of work of such shape and weight as to necessitate the use of radial drills, in which the holes to be made are of such size that the efficiency of the drilling depends more on speed than feed. To meet this class of work this drill press has been designed.

This machine will drive drills much larger than the ¾-inch size stated as the upward limit of its useful capacity, but the makers lay stress on the fact that this is the first radial drill ever put on the market that will use these smaller drills to advantage. Within its range the results obtained are great enough to entitle this machine to a sure position in the machine shop. As experiments in many cases have

shown, work can be performed 5 or 6 times as fast as with a regular high-grade radial drill. There are other advantages also in the use of the machine, such as a large saving in the power used, due to the elimination of friction in bearings, with a corresponding saving of belting and oiling. There is also an extension of the life of the machine due to the ease with which ball cups and cones on which most of the wear comes, may be replaced. Many of the features of the sensitive drill, built by the same makers, described in the July,



Sensitive Radial Drill Press.

1907, issue of MACHINERY, have been incorporated in this one, such, for instance, as the balance spindle drive, friction pinion, etc.

Friction has been reduced to a minimum by the use of ball bearings, and the driving is done by a single belt, eliminating entirely the use of gears. This gives a very sensitive and economical drive for the work for which the machine is designed. A patented idler device, as shown, makes it possible to use a single belt in the drive, and not interfere with the swinging of the arm through a radius of 180 degrees, with a uniform tension always maintained on the belt. The idler pulleys are arranged to take up slack in the belt, within reasonable limits. Instead of shifting the drill spindle in a sliding head along the arm to bring the drill to the point desired, a round table revolving on balls is used for supporting the work. This makes it easy, in combination with the swinging arm, to bring the drill quickly, and with very little effort, to any position on the work desired. The table is provided with a lock to hold it stationary when in use. A square table is provided to be used in drilling small work, to bring it to the proper height to be drilled easily.

The arm may be raised and lowered by a screw at the side of the column. The screw at the side of the arm provides for clamping it in any position required, and the column, which supports the arm, may be locked in any position by tightening the screws in the bracket provided for the purpose. The arm also has a hole for receiving the guide bar for the tapping fixture.

There are eight changes of speed, with a double speed countershaft run, as recommended, at 90 and 400 revolutions per minute, giving a range of speed at the drill point of from 60 to 975 revolutions per minute.

Although this machine is designed as a radial drill, it may be operated as a stationary drill by locking the revolving table and the arm, and clamping a sub-table to the revolving table by T-slots provided for the purpose.

COX'S PLANING AND SHAPING COMPUTER.

In the July issue mention was made of a Cox time and cost computer for boring and turning, which was distributed by the Bullard Machine Tool Co., at the recent Atlantic City convention of the American Railway Master Mechanics' Association. The veteran designer of this computer, Mr. William Cox, 53 Ann St., New York, has also designed the planing and shaping time and cost computer shown in the accompanying cut. This latest effort of Mr. Cox is consecutive number 120, and it indicates the total number of the computers he has gotten up, covering almost every branch of engineering activity. We understand that this computer is for sale to some one machine tool building concern which would care to use it for advertising souvenirs.

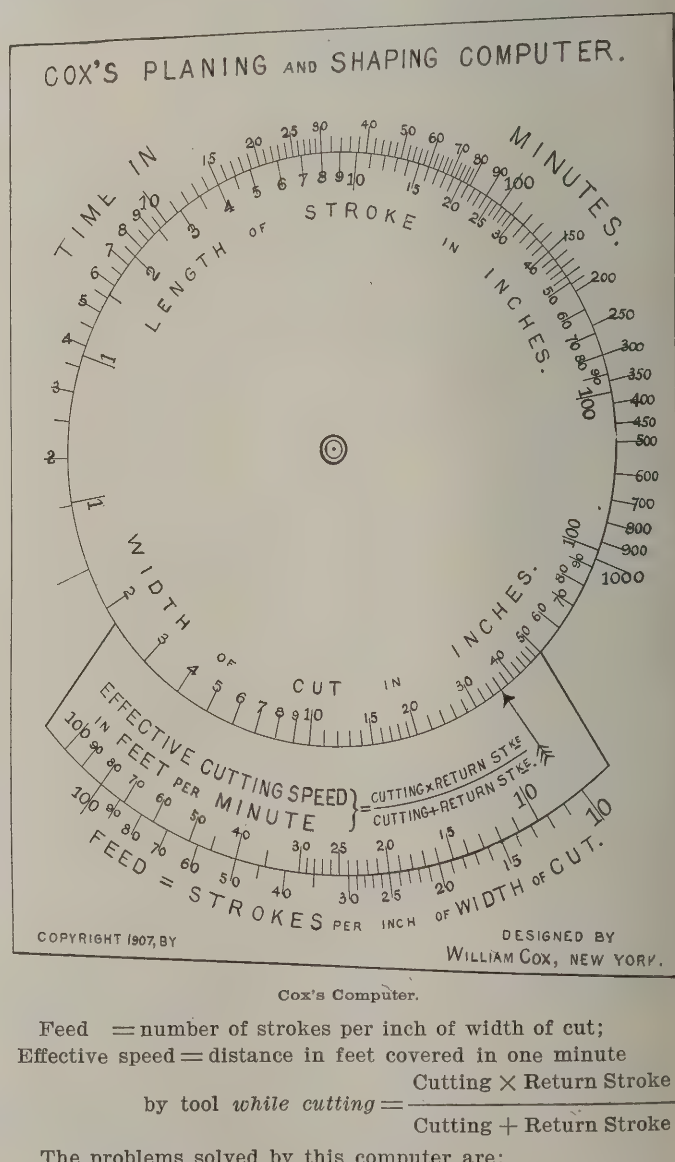
This computer is designed to give the time required for planing any given flat surface on a planing machine or on a shaper. It also gives the cost of performing such work at any wage rate per hour.

The formula it solves is:

$$\text{Time, in minutes} = \frac{\text{Stroke} \times \text{Width} \times \text{Feed}}{\text{Effective Speed} \times 12},$$

where,

Stroke = length of stroke, in inches;
Width = width of cut, in inches;



Cox's Computer.

Feed = number of strokes per inch of width of cut;
Effective speed = distance in feet covered in one minute

$$\text{by tool } \textit{while cutting} = \frac{\text{Cutting} \times \text{Return Stroke}}{\text{Cutting} + \text{Return Stroke}}.$$

The problems solved by this computer are:

1. The time required to plane any given surface of any length of stroke and width of cut, with any feed and cutting speed.

2. To find suitable cutting speed and feed, when the length of stroke and width of cut are known, and the time in which the work *should* be done has been predetermined in accordance with the wage rate, so as to bring the cost down to a given figure.

3. To find the cost of the work done at any wage rate when the required time has been ascertained, and *vice versa*, to find the time allowed for any given cost at any wage rate.

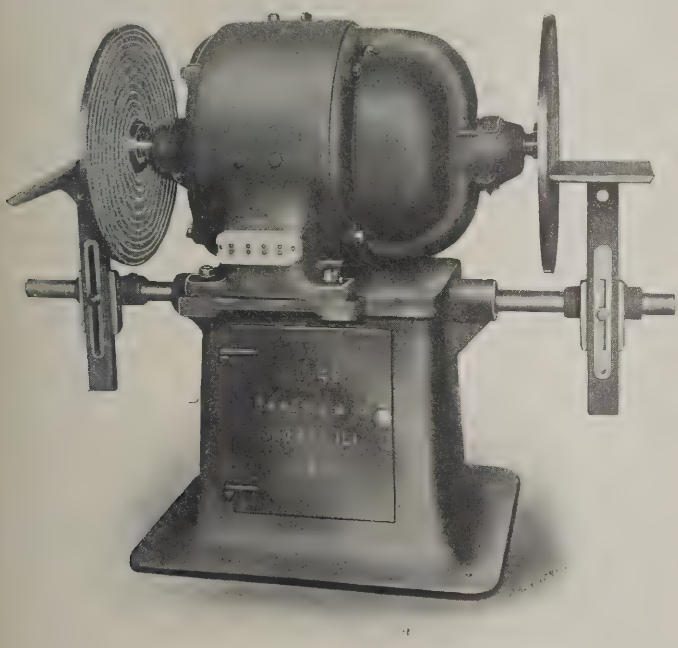
In the cut, a small sector scale for computing the cost is not shown, as it would cover some of the more important parts of the computer.

KRIPS-MASON PRESS ATTACHMENT FOR COUNTER-SINKING WASHERS.

The Krips-Mason Machine Co., 1636 N. Hutchinson St., Philadelphia, Pa. (who builds the press illustrated in the March, 1907, issue of MACHINERY, for making washers at one stroke), has recently added an improvement to the dies furnished with this machine. The purpose of this improvement is to countersink the washers produced. The countersink is deep, extending one-third or one-half way through the stock from which the washer is made. It is formed by a conical shoulder on the punch, which forms the countersink while the washer is held firmly on the die, thus making a very neat job.

BESLY NO. 40 PLAIN MOTOR-DRIVEN GRINDER.

Chas. H. Besly & Co., 13, 15, 17, 21 South Clinton St., Chicago, Ill., have built what they believe to be the largest motor-driven disk grinder ever constructed. This is shown in the accompanying halftone. It is a No. 40 plain machine, using 26-inch disk-wheels driven by a 20-horse-power General Electric direct current motor. The motor alone weighs a ton.



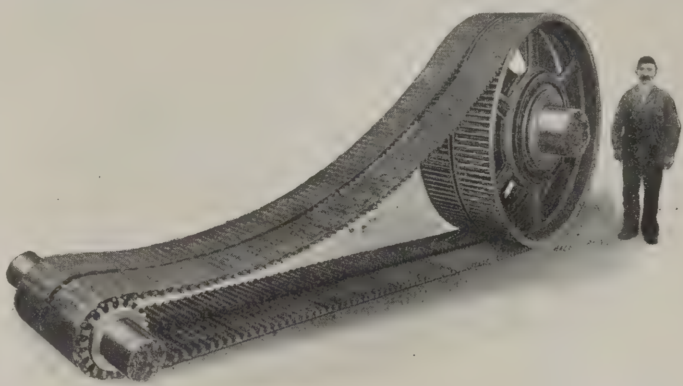
Heaviest Motor-driven Disk Grinder Built.

Four of the builders' patented spiral groove disks are provided with the machine, which is fitted with their regular adjustable tilting table. The controller and starting box are placed in the base of the machine, and may be reached by the door shown in the illustration. This prevents these parts from becoming clogged or short-circuited by powdered steel and abrasives.

RENOLD SILENT CHAIN DRIVES OF UNUSUAL SIZE.

The Link-Belt Co. of Philadelphia, Pa., has recently delivered a Renold silent chain drive of very unusual proportions to the Seattle Brewing & Malting Co., Seattle, Wash. This drive is the largest of this type in the country. It transmits 325 horse-power from the motor to the refrigerating machinery. Two chains, as shown in the cut, are run side by side on single wheels spaced 14 feet from center to center. The load is uniformly distributed by Dodge spring centers on the driven wheel. The peripheral speed of the chain is 1,100 feet per minute.

The Renold silent chain was fully described and illustrated in the August, 1901, issue of MACHINERY. Among its advantages are the facts that the load of the chain is uniformly distributed over all the teeth of both driving and driven gears which are in contact with it; that the stretch resulting from wear of the teeth is compensated by the construction of the chain, which automatically assumes a larger pitch diameter;



A 325 Horse-power Silent Chain Transmission.

and that the noise common with ordinary chain drives is entirely overcome. Even when the Renold chain becomes worn, the maximum efficiency will be maintained, although the demands may be severe enough to incapacitate ordinary drives. The chain will run in either direction and is not adversely affected by heat or cold, dampness or oil.

Another installation also of unusual interest has been furnished for the city of Columbia, S. C., under the supervision of Wm. M. Piatt, the assistant city engineer. This drive operates a Worthington centrifugal pump, and is driven by a horizontal turbine at the unusually high surface speed of 1,755 feet per minute. The shafts are 11 feet 7 inches from center to center, and 224 horse-power is transmitted.

A LINE OF SCREW-THREAD MICROMETERS.

In its work of making tools for accurate screw cutting, the Wells Bros. Co., of Greenfield, Mass., has developed a line of micrometers for the measurement of screw threads. These tools have proved so useful in their own work that they have decided to place them on the market. The system of measurement employed differs radically from that used in any other commercial thread micrometer. As may be seen by examining either of Figs. 1, 2 and 3 (in which various styles are shown) the measurement is taken between two points

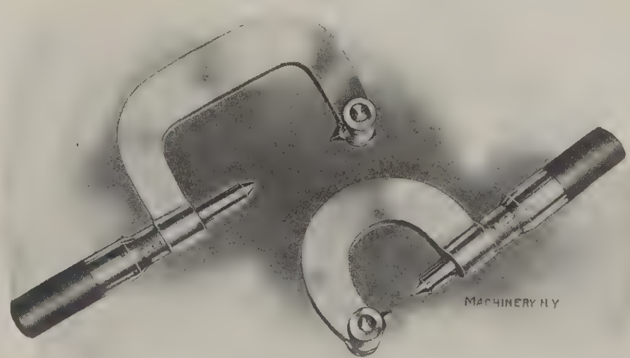


Fig. 1. Screw-thread Caliper made in Hand Micrometer Style.

formed to the angle of the thread, generally 60 degrees. The measuring point in the anvil has a side adjustment by micrometer screw, by which means it is set off from the center line of the spindle by a distance equal to one-half the lead of the screw, for single-threaded screws, or adjusted back to a central position for a double-threaded one. The micrometer spindle has a conical point similar to that in general use with thread micrometers. Both measuring points are flatted enough to clear the bottoms of all United States standard threads

within the range of the tool. This method of measurement, it will be seen, gages the threads on their inclined sides, and so gives what may be called the "pitch diameter," which is the only measurement of any value in determining the fit of a thread.

This principle is applied to the three forms of micrometer shown. In Fig. 1 is what the makers call their "hand thread micrometer." This is made in two sizes, one having a capacity up to and including 1 inch, while the larger one will measure

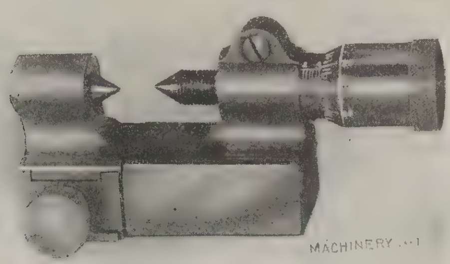


Fig. 2. Thread Caliper with Base, for General Shop Use.

threads from 1 to 2 inches diameter inclusive. In Fig. 2 is shown a "thread micrometer caliper for shop use." It is made somewhat heavier than the hand style, and is mounted on a base of its own. It is considered to be preferable to the micrometer style, in some ways, for the use of manufacturers, and is made in two sizes, the first having a capacity for screws from ¼ inch to 1 inch in diameter, and the larger one from ¾ inch to 1½ inch. The device, which is shown in Fig. 3, is made to cover a large range of sizes, the block

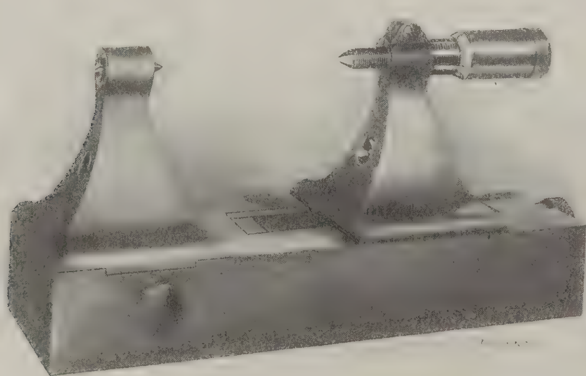


Fig. 3. Form of Device with Wide Range for General Manufacturing.

carrying the micrometer screw being arranged to clamp down at 1 inch intervals, and set to position by means of standard end gages placed between hardened steel plugs. As usually made, this style has a small size limit of 1½ inch diameter, with the upper limit at any reasonable point, as desired by the purchaser.

Wells Bros. Co. has issued a separate catalogue of gages, and has established a well-equipped department for the manufacture of these tools. This firm would be pleased to forward a copy of its gage catalogue on request.

* * *

The cost of fireproofing office buildings from 9 to 14 stories high, in our larger cities, has recently been the subject of an investigation, and the results have been published by the National Fireproofing Association. The figures show that, in general, the cost of the foundation and masonry work in such buildings is about one-third of the total cost. The steel frames cost about one-sixth, and the mechanical equipment and the furniture about one-fifth, the remaining part, or more than one-fourth, being expended for trim and finish. The experiences at Baltimore and San Francisco show that buildings of this kind in a conflagration may sustain damages in all respects excepting foundations and steel frames. As these two items represent a comparatively small percentage of the value of the building, the average fireproof building in a conflagration may easily sustain damage amounting to 70 per cent of its value.

INDUSTRIAL NOTES FROM EUROPE.

BRITISH TRADE TOPICS.

James Vose.*

The general aspect of industry in Great Britain points to a continuance of activity for some time to come. Considerable unrest, however, prevails among large bodies of workpeople in several industries. Engineers on the northeast coast are agitating for increased wages; in other parts the employment of the premium system is a cause of rupture, and in most districts resentment is still felt at the comprehensive scope of the conditions in the Engineering Trade Agreement, which makes for the security of employers. Railway employes of all grades are making efforts to improve their conditions as regards wages and hours. It is conceded that such a course is desirable, but the reduction in railway dividends likely to follow such concessions is considered excessive by the railway managements. However, it is hoped some slight benefit, at any rate, will be reaped by the men. A five per cent advance has been granted the cotton spinners, though weavers have been unsuccessful in their application. On the Continent, engineering labor is inclined to insist on advances in wages or reduction in the number of working hours, and, in certain branches, trade-union working conditions are being increasingly insisted on. In fact, the comparative docility, with which the Continental workman was often credited when labor topics were under discussion in other countries, is not now to be confidently counted upon. In Italy, in many instances, the somewhat sudden introduction of mechanical industries has upset the industrial equilibrium, and strikes or lockouts are frequent occurrences. The government, in order to assist the new industries, endeavors to discourage the emigration of labor to America. The utilization of hydro-electric power in Italy, which, it is realized, is a great national asset, is likely to cause considerable and beneficial economic changes in that tax-ridden country.

The spring and early summer has been cold and wet both in Great Britain and on the Continent, with quite marked effects on the automobile, cycle, and allied businesses. In these, the clothing, and other industries, effect has followed cause very rapidly, many being thrown out of employment or faced with considerable loss.

The Cargo Fleet Co. Steel Works.

In a previous article we mentioned the progress recently made in the equipment of a number of British iron and steel furnace plants and mills, and some particulars, as furnished to the Manchester Association of Engineers on a recent visit to the works of the Cargo Fleet Co., Ltd., Middlesboro, may be of interest. These works are situated about two miles from Middlesboro and consist of blast furnaces, with gas-driven blowing engines, coke ovens, steel furnaces, and rolling mills. The iron ore for the furnaces is obtained from the company's mines, about twenty miles away. The blast furnace plant consists of two furnaces, 90 feet high, with twelve Cowper stoves, each furnace capable of producing nearly 1,500 tons of pig iron per week, all of which is taken, molten, to the steel furnaces for conversion. There are seven Cockerill type gas blowing engines working on the single-acting Otto cycle, each engine delivering 14,000 cubic feet of free air per minute at a pressure up to 18 pounds per square inch. The cooling

* James Vose was born in Bolton, Lancashire, England, 1862. His education, other than that gained in common schools, was obtained by home study and in evening scientific schools. He served an apprenticeship in the repair shops of Geo. Hodgkinson & Son and Haslams, Ltd., both large cotton mills. He then worked as journeyman mechanic at Howarth Cryer & Co., Bolton; American Heald Co., Bolton; and Meldrum Bros., Ltd., Manchester, with which concerns he was a journeyman, foreman, and assistant superintendent; he was also in special charge of selection and use of all machine and allied tools and methods at Meldrum Bros., Ltd. He is now acting as consulting engineer on work-shop equipment. Mr. Vose has contributed to the trade press of Great Britain and the United States for several years. Address: 100 Ayres Road, Brooks Bar, Manchester, England.

water for the pistons and cylinder jackets is pumped by two electrically-driven pumps to the cooling tower. The gas for the blowing engines passes through three Theisen gas washers, two of which are capable of dealing with the gas from both the furnaces, amounting to about 20,000 cubic feet per minute. Each washer is driven by a 150 H. P. motor. Steam for two 1,000 H. P. turbo-generators and two Brown hoists by which the materials are automatically dumped into the furnaces, is furnished by nine water-tube boilers. Sixty tons of coal per hour is dealt with by the coal washing plant. The coke oven plant consists of 100 Kopper ovens fed by two double box coal compressors. The gas from the ovens passes to the by-product plant where sulphate of ammonia and tar are recovered. Sufficient gas is produced to supply 3,000 H. P. through gas engines.

The electric generating plant consists of a 350 K. W. compound steam direct-driven plant, two steam turbo-generators each of 750 K. W., two gas engines using coke-oven gas, each directly connected to 300 K. W. generators, and two gas engines using blast furnace gas, each directly connected to 375 K. W. generators. All the generators run in parallel at 220 volts continuous current. The steel smelting shop contains three 175 tons Talbot furnaces. The gas for these furnaces is supplied by ten mechanically stirred producers giving 150,000 cubic feet of gas per ton of coal. The furnaces are charged by an electrically-driven charging machine and two 40-ton overhead hot-metal cranes, while two 75-ton steel casting cranes are provided on the casting side of the furnaces. One 150-ton gas-fired mixer is installed.

Two rolling mills are at work. The cogging mill has 40-inch center of rolls, with 8 feet 6-inch rolls driven by a three-cylinder compound condensing engine, 45 x 52-inch. The finishing mill consists of four stands of rolls direct driven by an engine exactly similar to the cogging mill. The central condensing plant is capable of dealing with steam from three mill engines of the size already mentioned. The pump house is equipped with electrically-driven circulating pumps, steam-driven dry air pumps, condensor water pumps, steam-driven hydraulic pumps, and boiler feed pumps. The works are also provided with very extensive river frontage, and a wharf at which the products of the company can be loaded into deep-sea craft.

Factors Governing Selection of Special Tools.

It is often the case that tools introduced with a view of showing some working advantage over existing types may prove their claims within certain limits, but the increasing use of the new style does not preclude the simultaneous growth of the older ones. We may instance portable drilling machines, etc., driven electrically or by compressed air. The question of which class to select may easily be governed quite as much by the particular shop conditions as by the relative economy or efficiency of the drills themselves. In one shop compressed air may be used quite freely for a number of purposes, and electricity scarcely employed. The use of air-driven drills is thus governed by factors more or less apart from its merits as a tool. In the next shop, current may be universally available, while compressed air may not be called for, and the electrical drill is, of course, employed. In other shops both sources of power are at disposal, and it may be a convenience to have both types of drills in use, but that which is found to be the most economical in working cost is selected as the standard shop tool. Even then it may pay to retain the old rope-driven portable drill in some instances. We have been led to make the above comments by the fact that concerns formerly identified with the production of one particular type now offer both, without attempting to draw invidious comparisons, an attitude which might, with advantage, be more widely adopted.

Small Lathes.

Several firms over here make quite a specialty of small lathes, etc., worked by treadle or power. Drummond Bros., Ltd., Guildford, Surrey, are making a feature of such lathes with special reference to their employment for motor car repairing, etc. The saddles are arranged to act as boring carriages, if required, and generally the lathe is so designed as to adapt it to a wide range of duties, such as met with in repair shops. The owners of many large English country houses find it advisable to install such a tool for the use of their chauffeur or engineer, as the number of motor cars kept at, and the mechanical equipment of, such large houses is often quite extensive. Many cars being of Continental manufacture, the lathes mentioned are arranged to cut metric as well as ordinary screw threads. These tools being produced in large quantities, are sold at remarkably low prices, considering the good work put into them. We hope later to give some further particulars of these lathes.

Amateurs' Lathes.

G. Birch, Salford, Manchester, has for many years devoted special attention to the production of amateur lathes made to suit customers' individual requirements. The class of users for whom these tools are made does not so much consider price as all round adaptability and accuracy. They are used for experimental work of a precisional nature by scientists. Others are used by wealthy men simply as a hobby, many of these users turning out beautiful specimens of medallion work by profiling methods, in ivory, ebony, etc. Some of the work done is perhaps scarcely to be classed as turning, as the lathes are equipped also to act as milling and drilling machines, slotters, shapers, etc., in fact they become practically complete machine shops in themselves. We were recently informed of such a lathe which was forwarded to an almost inaccessible part of India for the purpose of providing congenial occupation during the leisure hours of a military officer of high rank. It has been remarked that probably only good would result if such a class of users could be created among the many extremely wealthy men found in the United States. JAMES VOSE.

Manchester, England, June 29, 1907.

MISCELLANEOUS FOREIGN NOTES.

BRITISH EXPORTS OF MACHINERY.—The year 1906 marks a record in British exports of machinery, and to those who regard foreign trade as an index of prosperity, the present state of the British machine building trade is the best possible. The total value of exported machinery was approximately $130,000,000. This figure is more than 50 per cent larger than that of five years ago, and more than 25 per cent larger than in 1904. The increase from the previous year was 15 per cent.

BRITISH INDUSTRIAL COMBINATIONS.—Ever since the formation of the steel trust in this country, amalgamations have been the order of the day, even in Europe, the latest instance of this movement being the joint working agreement between the Belfast firm of Harland & Wolff and John Brown & Co. of Clydebank and Sheffield. If the report referred to by the London *Times* is correct, this combination will be the most important amalgamation that has ever taken place in the shipbuilding world.

TRADE CONDITIONS IN AUSTRIA.—Consular reports from Austria indicate that during the year 1906 there was an unusual industrial activity throughout the country. The output in the most important industries increased from 10 to 20 per cent as compared with the previous year, and factories were enlarged in numerous cases. Wages increased about 10 per cent and the general prosperity of the country was greater than ever. The only drawback was the increased cost of raw materials, as well as the higher cost of living.

MACHINE TOOL TRADE IN HOLLAND.—A report by Consul F. D. Hill, Amsterdam, states that American machine tools are subjected to a keen German competition in Holland on account of the fact that American tools are, relatively, priced somewhat higher than German tools sold in that country. The actual price charged for the best tools made in Europe is about the same as the price of American tools, but the Germans, in general, use harder material for their machines, which insures longer life. Mr. Hill states that the packing of American machine tools is considered very good and much better than that of European tools, a thing that is gratifying in view of so many consular complaints of late in regard to poor packing of American merchandise in general. The gen-

eral complaint of slow and delayed delivery is, however, as prominent in this report as in almost all other reports by our consuls in Europe.

The Automobile Industry in Europe.—A French statistician, Mr. Faroux, estimates that in 1906 there were 55,000 automobiles built in France, 28,000 in Great Britain, 22,000 in Germany, 19,000 in Italy, and 12,000 in Belgium. Until a year ago France led the world in the production of motor vehicles, but during the last year the United States has taken the lead, the number of motor cars manufactured in this country being estimated at 60,000 in 1906. In 1901 the United States built only 314 cars, and France in the same year 23,711. It is said that in all 550,000 cars have been manufactured since the experiment with self-propelled vehicles succeeded, and these cars have been sold for a sum exceeding $1,000,000,000, or for a price averaging about $2,000 a car. Many of the present European cars, however, sell for considerably less than $1,000, the average price of German automobiles being $1,080 in 1906.

The Present Prospect of Machine Tool Building in Germany.—According to reports from Germany, the conditions in the machine tool trade appear to be steadily improving. Many works report that it is quite impossible for them to take any new orders for delivery during 1907. There has been some anxiety that the continually increased price of machine tools would be harmful, but it has been found that the customer is more concerned about the period of delivery than about the increase of prices. However, although the machine tool builders' product commands a higher price, it is not probable that this will bring any higher profits, inasmuch as the rise in raw material has been proportionally as great as the increase in the selling price of the finished product. It is not likely that German machine tool builders will increase their plants to any great extent at the present time, but rather wait until there will be a less general prosperity, and a possibility offered of making additions at cheaper rates than could now be done.

German Manufacturers Copy American Trust Methods.—Consul-General Richard Guenther, of Frankfort, writes that scarcely a day passes but the German newspapers report a new trust or syndicate in some line of German manufacturing. The causes assigned for these centralization movements are the increased cost of materials, the greater demands of employes, and the losses brought about by injudicious competition among manufacturers and dealers. The object aimed at is to protect and promote the interests of the individual members of the trade. In the pursuing of this aim, however, the restrictions established cannot but cause a reaction in the trade, inasmuch as the rise of prices may be followed by a decrease in demand or a limitation of output. One of the important amalgamations at the present time is the bicycle trust. The keen competition in this trade has brought down prices to a very low level, and leading bicycle firms, wanting to keep prices up, have concluded that the only possibility for doing so is syndicate work.

Ernst Schiess, Werkzeugmaschinenfabrik A. G., Düsseldorf, Germany, has brought out some new machine tools, two of which are of particular interest. One is a cylinder boring machine, designed for boring cylinders up to 9 feet in diameter and intended for high speed cutting tools. This machine consists of a head and tail-stock mounted on a heavy base plate, the center of the spindle being 5 feet 4 inches above the base plate. The machine is driven by a 15-horse-power motor. The boring bar has an automatic feed varying from 0.020 to 0.600 inch per revolution. The revolutions of the spindle range between 0.54 and 3.6 per minute. The maximum boring length is 10 feet. The other machine mentioned is a horizontal boring and shaping machine, consisting of a bed with a movable column placed upon it, on which is mounted the counterbalanced head-stock. This machine is driven by a 12- or 15-horse-power motor. The diameter of the boring spindle is 7 inches, the length of the boring feed is 5 feet 4 inches, the vertical traverse of the head-stock is 10 feet, and the horizontal traverse of the column, 20 feet. The revolutions vary from 10 to 110 per minute.

The Condition of Germany's and Great Britain's Foreign Trade.—Consul Thos. S. Norton, of Chemnitz, reports that while the German foreign trade has been comparatively small in regard to machinery during the past year, the German machine industry is in an exceptionally flourishing state, and the falling off in exports simply proves that the demands of the home market are so immense as to require all the attention of the machine builders. The inability of Germany, as well as of the United States, to supply the world's market with machine tools to the full amount of the demand has been very favorable to Great Britain, the foreign trade of which has in regard to machine tools been much greater during the last year than ever before. There have often been expressed optimistic views in England on account of this fact, but one of their leading technical journals calls attention to the fact that while the past year has been exceedingly prosperous, England may nevertheless meet with difficulties, when the high tide of prosperity recedes in Germany and in the United States, because these two countries will then bring their competition to play against Great Britain more severely than they are able to do at the present time, and is warning English machine tool builders from expecting too much of the future.

* * *

OPENING OF KEUFFEL & ESSER CO.'S NEW FACTORY.

The formal opening of the new factory buildings of the Keuffel & Esser Co., in Hoboken, N. J., took place on July 20, in the presence of the officers and employes of the company, and many invited guests. The new buildings, which will be devoted exclusively to the manufacture of the company's well-known products of engineers' and draftsmen's supplies, consist of two very handsome reinforced concrete constructions, one five and the other six stories high, and represent, without exaggeration, the latest progress in factory design. They are entirely fireproof, even the window sashes being made of metal, and provided with wire glass. When open, the windows are fastened on fusible links, so as to close automatically in case of fire. Besides, there is an extensive system of automatic fire sprinklers.

One of the new buildings is primarily intended for offices and storerooms, and the general offices, hitherto located at 127 Fulton St., New York, will in the future be located here, the building in New York being retained only as a general store, and for showrooms.

The opening of the new factory also marks the forty years' anniversary of the establishment of the firm of Keuffel & Esser, the business of the firm having been started July 19, 1867, by William Keuffel and Hermann Esser. In commemoration of this as well, the company had invited all its employes to take part in the opening exercises, and afterward gave a luncheon and entertainment on one of the floors in the new building for its force, amounting to upward of 700 persons.

* * *

PERSONAL.

Will Mr. William C. Terry please send his present address? Mail addressed to him at Boston, Mass., was not delivered.

R. E. Fox, Jr., has resigned his position as manager of the New York office of the Platt Iron Works Co. to become secretary and manager of the sales department of the Engineer Company, New York.

Maurice Gesundheit and Henry Osgood have united under the firm name of Gesundheit, Osgood Co., with offices at 43 Cedar Street, New York, as manufacturing engineers and business methodizers.

The many friends of Mr. P. E. Montanus, the president of the Springfield Machine Tool Company of Springfield, Ohio, and secretary of the National Machine Tool Builders' Association, will hear with regret of the sudden death of Mrs. Montanus, which occurred last month. This estimable lady was greatly esteemed in Springfield, where she had spent many years of her life, and where she had been prominent socially and in charitable work.

Contributions and data suitable for publication in these Data

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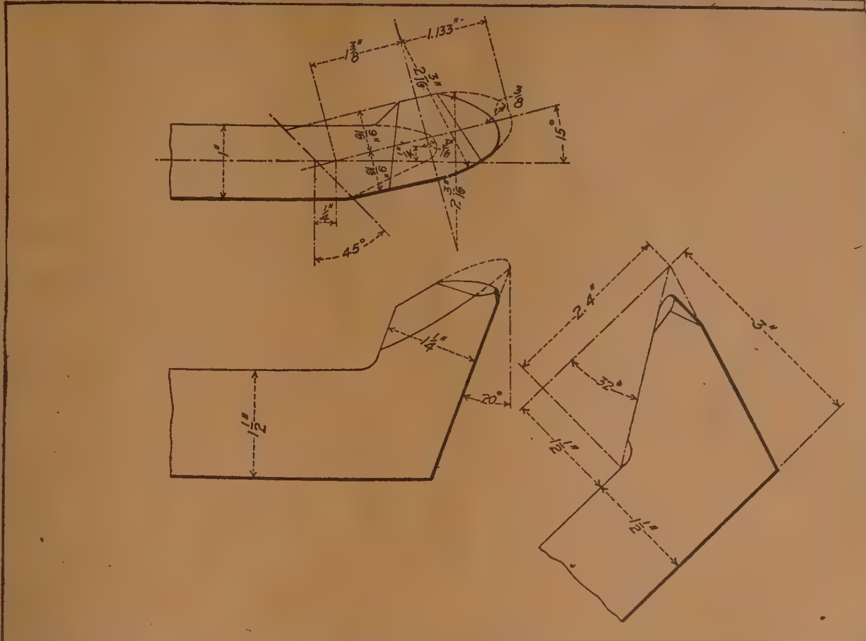
LATHE CUTTING SPEEDS, STEEL.—I.



Detailed Dimensions of 1-inch Round Nose Roughing Tool. Forged Outline shown by Dotted Lines and Ground Form by Full Lines. Clearance, 6 degrees; Back slope, 8 degrees, and Side Slope 14 degrees.

Standard 1¼ inch Tool

Depth of Cut in Inches	Feed in Inches	Cutting Speed, in feet per minute for a tool which is to last 1 hour and 30 minutes before regrinding: Soft Steel	Medium Steel	Hard Steel
3/32	1/64	518	259	118
3/32	1/32	366	183	83.2
	1/16	257	129	58.4
	3/32	209	105	47.5
1/8	1/64	450	225	102
	1/32	317	158	72.0
	1/16	223	112	50.7
	3/32	182	90.8	41.4
	1/8	157	78.5	35.7
3/16	1/64	370	185	84.1
	1/32	260	130	59.1
	1/16	183	91.7	41.6
	3/32	149	74.6	33.8
	1/8	129	64.5	29.3
	3/16	105	52.6	23.8
1/4	1/64	322	161	73.2
	1/32	227	113	51.6
	1/16	159	79.7	36.1
	3/32	130	65.0	29.5
	1/8	112	56.1	25.5
	3/16	91.4	45.7	20.8
3/8	1/64	264	132	60.0
	1/32	186	93.1	42.3
	1/16	131	65.5	29.8
	3/32	107	53.4	24.1
	1/8	92.2	46.1	20.8
1/2	1/64	230	115	52.3
	1/32	162	80.9	36.8
	1/16	114	56.9	25.9
	3/32	92.6	46.3	21.0

Standard 1 inch Tool

Depth of Cut in Inches	Feed in Inches	Soft Steel	Medium Steel	Hard Steel
3/32	1/64	490	245	111
	1/32	339	169	77.0
	1/16	235	117	53.4
	3/32	189	94.5	43.0
1/8	1/64	427	214	97.0
	1/32	296	148	67.2
	1/16	205	102	46.6
	3/32	165	83.0	37.5
	1/8	142	71.0	32.3
3/16	1/64	358	179	81.3
	1/32	247	124	56.1

Fred W. Taylor, Proceedings of A. S. M. E., December, 1906.

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LATHE CUTTING SPEEDS, STEEL.—II.

Standard 1 inch Tool (Continued)

Depth of Cut in Inches	Feed in Inches	Cutting Speed in feet per minute for a tool which is to last 1 hour and 30 minutes before regrinding: Soft Steel	Medium Steel	Hard Steel
3/16	1/16	171	85.5	38.8
	3/32	138	69.0	31.3
	1/8	118	59.0	26.8
	3/16	95.0	47.5	21.6
1/4	1/64	315	157	71.6
	1/32	218	109	49.5
	1/16	150	75.0	34.1
	3/32	121	60.5	27.5
	1/8	104	52.0	23.6
3/8	1/64	263	132	59.8
	1/32	182	91.0	41.4
	1/16	126	62.8	28.5
	3/32	101	50.6	23.0
1/2	1/64	232	116	52.7
	1/32	161	80.5	36.6
	1/16	111	55.7	25.3

Standard 7/8 inch Tool

Depth of Cut in Inches	Feed in Inches	Soft Steel	Medium Steel	Hard Steel
3/32	1/64	476	238	108
	1/32	325	162	73.8
	1/16	222	111	50.4
	3/32	177	88.4	40.2
1/8	1/64	420	210	95.5
	1/32	286	143	65.0
	1/16	195	97.6	44.4
	3/32	156	77.9	35.4
	1/8	133	66.4	30.2
3/16	1/64	352	176	80.0
	1/32	240	120	54.5
	1/16	164	82	37.3
	3/32	131	65.5	29.8
	1/8	112	56.0	25.5
1/4	1/64	312	156	70.9
	1/32	213	107	48.4
	1/16	145	72.6	33.0
	3/32	116	58.1	26.4
3/8	1/64	264	132	60.0
	1/32	180	90.2	41.0
	1/16	122	61.1	27.8
1/2	1/64	237	118	53.8
	1/32	162	80.8	36.7

Standard 3/4 inch Tool

Depth of Cut in Inches	Feed in Inches	Soft Steel	Medium Steel	Hard Steel
3/32	1/64	482	241	110
	1/32	323	161	73.4
	1/16	217	108	49.3
	3/32	172	85.8	39.0
1/8	1/64	423	212	96.1
	1/32	284	142	64.5
	1/16	190	95.2	43.2
	3/32	151	75.3	34.2
	1/8	128	63.8	29.0
3/16	1/64	358	179	81.4
	1/32	240	120	54.5
	1/16	161	80.5	36.6
	3/32	127	63.7	28.7
1/4	1/64	320	160	72.7
	1/32	215	107	48.8
	1/16	144	72	32.7
3/8	1/64	276	138	62.7
	1/32	185	92.4	42.0

Standard 5/8 inch Tool

Depth of Cut in Inches	Feed in Inches	Soft Steel	Medium Steel	Hard Steel
1/16	1/64	548	274	125
	1/32	358	179	81.6
	1/16	235	117	53.3
3/32	1/64	467	234	106
	1/32	306	153	69.5
	1/16	200	100	45.5
	3/32	156	78.0	35.5
1/8	1/64	417	209	94.8
	1/32	273	136	62.0
	1/16	179	89.3	40.6
	3/32	140	69.8	31.7
3/16	1/64	362	181	82.2
	1/32	236	118	53.8
	1/16	155	77.4	35.2
1/4	1/64	328	164	74.5
	1/32	215	107	48.8
3/8	1/64	286	143	65.0

Standard 1/2 inch Tool

Depth of Cut in Inches	Feed in Inches	Soft Steel	Medium Steel	Hard Steel
1/16	1/64	510	255	116
	1/32	322	161	73.2
	1/16	203	102	46.2
3/32	1/64	445	223	101
	1/32	281	141	63.9
	1/16	177	88.7	40.2
	3/32	135	67.4	30.7
1/8	1/64	404	202	91.8
	1/32	255	128	57.9
	1/16	161	81	36.6
3/16	1/64	359	179	81.6
	1/32	226	113	51.4
1/4	1/64	330	165	25.0

Fred W. Taylor, Proceedings of A. S. M. E., December, 1906.

e solicited. Payment will be made for all accepted matter.

This data sheet is made up so as to be readily bound. It may be cut into four sections, 6x9 inches in size, and bound into note-book form for convenient reference, by means of staples inserted into holes punched at points indicated.

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LATHE CUTTING SPEEDS, CAST IRON.—I.

Standard 1¼ inch Tool

Cutting Speed, in feet per minute for a tool which is to last 1 hour and 30 minutes before regrinding

Depth of Cut in Inches	Feed in Inches	Soft Cast Iron	Medium Cast Iron	Hard Cast Iron
3/32	1/64	239	119.6	69.8
	1/32	191	95.3	55.6
	1/16	142	70.8	41.3
	3/32	118	59.1	34.4
	1/8	103	51.1	30.2
	3/16	85.0	42.5	24.8
1/8	1/64	216	108	63.1
	1/32	172	86.2	50.3
	1/16	128	64.0	37.3
	3/32	107	53.4	31.2
	1/8	93.4	46.7	27.3
	3/16	76.8	38.4	22.4
3/16	1/64	187	93.5	54.6
	1/32	149	74.6	43.6
	1/16	111	55.5	32.7
	3/32	92.5	46.3	27.0
	1/8	73.1	36.5	21.3
	3/16	66.4	33.2	19.4
1/4	1/64	168	84.1	49.1
	1/32	134	67.2	39.2
	1/16	99.8	49.9	29.1
	3/32	83.2	41.6	24.3
	1/8	72.6	36.3	21.2
	3/16	59.7	29.8	17.4
3/8	1/64	144	71.8	41.9
	1/32	115	57.3	33.4
	1/16	85.1	42.6	24.8
	3/32	70.9	35.5	20.7
	1/8	62.0	31.0	18.1
	3/16	51.0	25.5	14.9
1/2	1/64	131	55.6	38.3
	1/32	105	52.3	30.5
	1/16	77.6	38.8	22.7
	3/32	64.7	32.4	18.9
	1/8	56.6	28.3	16.5
	3/16	46.5	23.3	13.6
3/4	1/64	112	56.0	32.7
	1/32	89.2	44.6	26.0
	1/16	66.2	33.1	19.3
	3/32	55.2	27.6	16.1
	1/8	48.3	24.2	14.1
	3/16	39.7	19.8	11.6

Standard 1 inch Tool

Depth of Cut in Inches	Feed in Inches	Soft Cast Iron	Medium Cast Iron	Hard Cast Iron
3/32	1/64	226	113	66.0
	1/32	177	88.4	51.6
	1/16	130	64.8	37.8
	3/32	107	53.5	31.2
	1/8	92.8	46.4	27.1
	3/16	75.7	37.8	22.1
1/8	1/64	205	102	59.8
	1/32	160	85.1	46.8
	1/16	118	58.8	34.3
	3/32	97.0	48.5	23.3
	1/8	84.2	42.1	24.6
	3/16	68.6	34.3	20.0
3/16	1/64	181	90.6	52.9
	1/32	142	70.8	41.3
	1/16	104	51.9	30.3
	3/32	85.8	42.9	25.0
	1/8	74.3	37.2	21.7
	3/16	60.6	30.3	17.7
1/4	1/64	165	82.3	48.1
	1/32	129	64.4	37.5
	1/16	94.3	47.1	27.5
	3/32	77.8	38.9	22.7
	1/8	67.5	33.7	19.7
	3/16	55.0	27.5	16.1
3/8	1/64	143	71.5	41.8
	1/32	112	56.0	32.6
	1/16	81.9	41.0	23.9
	3/32	67.6	33.8	19.7
	1/8	58.6	29.3	17.1
	3/16	57.5	28.7	16.8
1/2	1/64	132	66.2	38.6
	1/32	104	51.6	30.2
	1/16	75.8	37.9	22.1
	3/32	62.6	31.3	18.3
	1/8	54.2	27.1	15.8
	3/16	44.2	22.1	12.9

Standard 7/8 inch Tool

Depth of Cut in Inches	Feed in Inches	Soft Cast Iron	Medium Cast Iron	Hard Cast Iron
3/32	1/64	220	110	64.2
	1/32	169	84.6	49.4
	1/16	122	61.2	35.7
	3/32	99.8	49.9	29.1
	1/8	86.4	43.2	25.2
	3/16	70.1	35.1	20.5
1/8	1/64	202	101	58.9
	1/32	156	77.8	45.4
	1/16	112	56.2	32.8
	3/32	91.8	45.9	26.8
	1/8	79.3	39.7	23.2
	3/16	64.3	32.2	18.8

Fred W. Taylor, Proceedings of A. S. M. E., December, 1906.

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LATHE CUTTING SPEEDS, CAST IRON.—II.

Standard 7/8 inch Tool (Continued)

Cutting Speed, in feet per minute for a tool which is to last 1 hour and 30 minutes before regrinding

Depth of Cut in Inches	Feed in Inches	Soft Cast Iron	Medium Cast Iron	Hard Cast Iron
3/16	1/64	178	89.0	52.0
	1/32	137	68.6	40.1
	1/16	99.4	49.7	29.0
	3/32	81.0	40.5	23.7
	1/8	70.1	35.0	20.5
	3/16	56.8	28.4	16.6
1/4	1/64	163	81.5	47.7
	1/32	126	62.9	36.7
	1/16	90.8	45.4	26.5
	3/32	74.1	37.0	21.6
	1/8	64.1	32.0	18.7
	3/16	52.0	26.0	15.2
3/8	1/64	144	71.8	41.9
	1/32	111	55.4	32.3
	1/16	80.0	40.0	23.4
	3/32	65.3	32.6	19.1
	1/8	56.4	28.2	16.5
	3/16	45.8	22.9	13.4
1/2	1/64	135	67.5	39.4
	1/32	104	52.1	30.4
	1/16	75.2	37.6	22.0
	3/32	61.4	30.7	17.9
	1/8	43.1	21.6	12.6

Standard 3/4 inch Tool

Depth of Cut in Inches	Feed in Inches	Soft Cast Iron	Medium Cast Iron	Hard Cast Iron
3/32	1/64	222	111	65.0
	1/32	169	84.3	49.2
	1/16	120	59.8	34.9
	3/32	97.0	48.5	28.3
	1/8	83.4	41.7	24.4
	3/16	66.4	33.2	19.4
1/8	1/64	203	102	59.3
	1/32	156	78.2	45.6
	1/16	110	55.0	32.0
	3/32	88.8	44.4	25.9
	1/8	76.2	38.1	22.3
	3/16	60.9	30.4	17.8
3/16	1/64	181	90.6	52.9
	1/32	137	68.5	40.0
	1/16	97.7	48.9	28.5
	3/32	78.0	39.0	22.8
	1/8	67.5	33.7	19.7
	3/16	54.2	27.1	15.8
1/4	1/64	167	83.6	48.8
	1/32	126	63.2	36.9
	1/16	90.8	45.4	26.3
	3/32	72.7	36.3	21.2
	1/8	62.7	31.3	18.3
3/8	1/64	150	75.0	43.8
	1/32	113	56.7	33.1
	1/16	81.0	40.5	23.6
	3/32	65.5	32.7	19.1

Standard 5/8 inch Tool

Depth of Cut in Inches	Feed in Inches	Soft Cast Iron	Medium Cast Iron	Hard Cast Iron
3/32	1/64	216	108	63.0
	1/32	160	80.0	46.6
	1/16	110	55.0	32.2
	3/32	88.4	44.2	25.8
	1/8	75.4	37.7	22.0
1/8	1/64	200	100	58.6
	1/32	148	74.0	43.3
	1/16	104	51.8	30.2
	3/32	82.6	41.3	24.1
	1/8	69.6	34.8	20.3
3/16	1/64	183	91.6	68.0
	1/32	135	67.5	39.4
	1/16	94.0	47.0	27.4
	3/32	75.4	37.7	22.0
	1/8	64.3	32.2	18.8
1/4	1/64	171	85.7	50.1
	1/32	126	63.2	36.9
	1/16	87.8	43.9	25.6
	3/32	70.4	35.2	20.6
3/8	1/64	156	77.8	45.4
	1/32	116	57.8	33.8
	1/16	79.7	39.9	23.3

Standard ½ inch Tool

Depth of Cut in Inches	Feed in Inches	Soft Cast Iron	Medium Cast Iron	Hard Cast Iron
3/32	1/64	206	103	60.0
	1/32	147	73.3	42.8
	1/16	97.5	48.8	28.5
	3/32	76.0	38.0	22.2
	1/8	64.1	32.1	18.7
1/8	1/64	194	97.0	56.7
	1/32	138	69.3	40.4
	1/16	93.1	46.5	27.2
	3/32	72.1	36.1	21.3
	1/8	41.8	20.9	12.2
3/16	1/64	182	91.0	53.0
	1/32	128	64.0	37.7
	1/16	86.1	43.1	25.1
	3/32	67.4	33.7	19.6
1/4	1/64	173	86.3	50.4
	1/32	122	61.0	35.7
	1/16	81.9	41.0	23.9

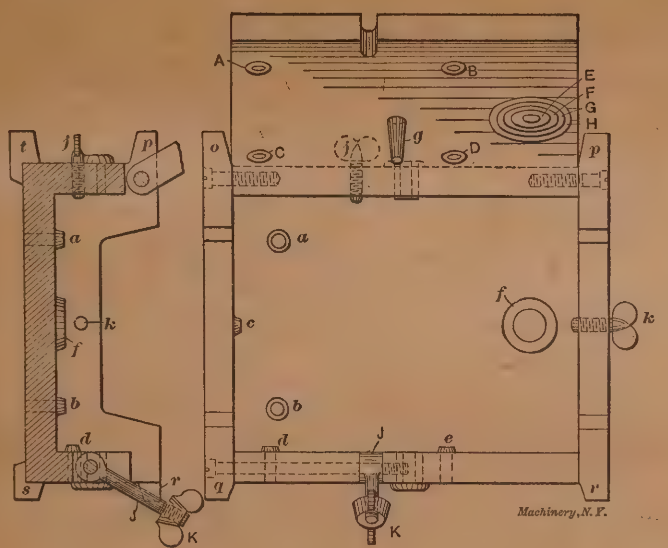
Fred W. Taylor, Proceedings of A. S. M. E., December, 1906.

PUNCH PUNCH PUNCH PUNCH PUNCH PUNCH

These operation sheets, covering every class of shop work, are a feature of all Editions of MACHINERY, and appear every month. They may be cut along the top and margin lines for filing and binding. Suitable binders of sufficient capacity to hold four years' issues will be supplied by THE INDUSTRIAL PRESS, 49-55 Lafayette Street, New York, for 25 cents each, including postage.

SHOP OPERATION SHEET NO. 10.

Oscar E. Perrigo. MACHINERY, August, 1907.



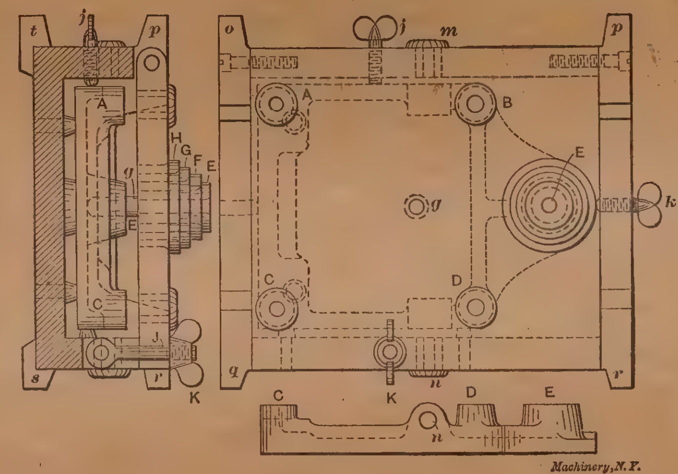
To Clean and Prepare a Drill Jig for Use, and Clamp the Piece of Work Therein.

NOTE.—A plan of a "box jig" is shown above, with the cover opened, as it would appear after removing the last casting drilled in it. At the left is a cross-section of the jig in the same condition. The work is a stiff casting, so the jig is comparatively simple in construction, without the refinements necessary to prevent distortion of slender work.

1. Clean the jig thoroughly by brushing out all chips and dirt from its inside, and particularly from the contact points *a, b, c, d, e, f* and *g*, and the surfaces where the lid shuts, so that it will close accurately.
2. See that the removable bushings, *A, B, C, D*, are in place and pushed down to their shoulders.
3. See that the compound bushings, consisting of the bushings *E, F, G, H*, one inside of the other, are clean and pushed down into place.
4. Place the casting in the jig, the bottom resting on the contact pins *a, b*, and the contact circle *f*. Press the front side against the contact pins *d, e*, and the broad end against the contact pin *c*. Screw up lightly the binding screws *j* and *k*.
5. Close the lid and see that the pressure pin *g* rests fairly on the casting. Swing up the pivoted lock-bolt *J* and screw down the nut *K* lightly.
6. Screw up successively the binding screws *j, k*, and the lock-bolt nut *K*.

SHOP OPERATION SHEET NO. 11.

Oscar E. Perrigo. MACHINERY, August, 1907.



To Drill Vertical and Horizontal Holes in a Casting, as Provided for by the Jig.

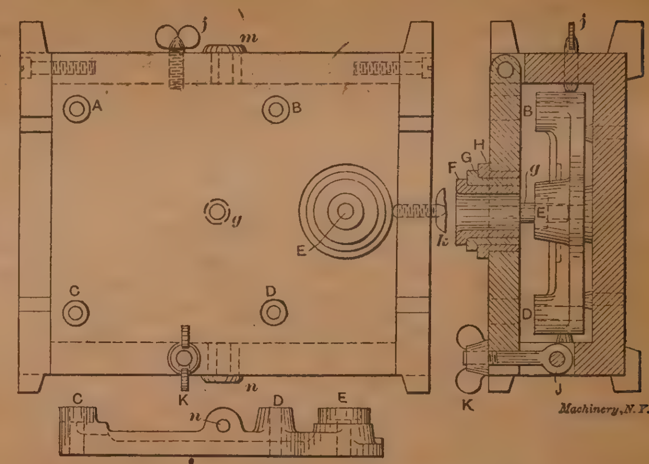
NOTE.—A plan of the jig is shown above, with the cover closed. The casting to be drilled is shown in dotted lines. A cross-section is shown at the left in which an end elevation of the casting is given. The bushings *E, F, G* and *H*, composing the compound bushing, are shown in place inside of each other. If desired, these bushings may be made without reference to each other, each being large enough on the outside to fit the hole in the jig body. Both methods are in use, and both represent good practise.

1. Fasten in the spindle of the drill-press a drill of suitable diameter for the holes at *A, B, C* and *D*, and with the jig lying on the drill table, lid-side up, proceed to drill these four holes.
2. Change the drill for one of the proper diameter and drill the hole at *E*.
3. Change the drill for one of proper diameter; turn the jig on its edge, and drill the hole at *m*.
4. Reverse the jig on its opposite edge, and drill the hole at *n*.

NOTE.—Be careful that the drill table is brushed off clean, and that the jig feet *o, p, q, r, s* and *t* rest fairly on the drill table, with no dirt to interfere with its solid bearing; otherwise poor work and broken drills may be the result. A jig with a three-point bearing on the table should never be used, as it is difficult to tell whether or not it is fairly seated. If a drill press with three or more spindles is available, the tools used in Steps 1, 2 and 3 may be permanently held in them, avoiding the frequent changes otherwise necessary.

SHOP OPERATION SHEET NO. 12.

Oscar E. Perrigo. MACHINERY, August, 1907.



To Tap, Ream, Counterbore, Face and Size a Boss on a Casting, as Provided for by the Jig.

NOTE.—The four holes *A, B, C* and *D* are to be tapped; the hole *E* to be reamed and counterbored; the boss *E* to be faced, and its diameter finished in size. The work is supposed to be in place, with the holes drilled.

1. Remove the bushings *A, B, C* and *D*. Change the drill-holder for a tap-holder. Put in the proper tap, reduce the speed, and proceed to tap the holes *A, B, C* and *D*.
2. Remove the tap-holder. Remove the drill bushing *E*, leaving bushing *F*, as shown in the end section. Put in a drill-chuck, in which place a reamer of proper diameter, and ream the hole at *E*.
3. Remove the reamer and put in a counterbore of proper diameter, provided with a stop collar to govern the depth. Counterbore the hole at *E*. (The counterbore is steadied by the bushing because the reamed hole is not large enough to guide a pilot strong enough to insure good work.)
4. Remove the bushing *F*. Remove the counterbore and put in an end mill of diameter to fit the bushing *G*. With a stop collar to govern the depth, face off the boss *E*.
5. Remove bushing *G*. Remove end-mill and put in a hollow end-mill of diameter to fit bushing *H*, and recess to size the boss *E*. Use a stop collar to govern the depth. Finish the outside of boss *E* as shown.

NOTE.—The stop collars used on these tools may be fixed by a set-screw, and adjusted so as to stop against the top of a bushing and so determine the depth. If a drill-press with five or more spindles is available, the tools used in Steps 1 to 5 may be permanently held in them, avoiding the frequent changes otherwise necessary.

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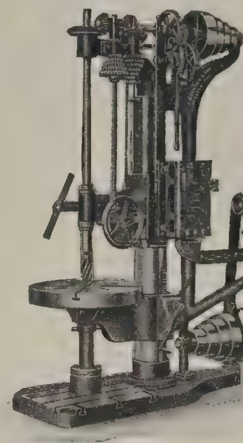

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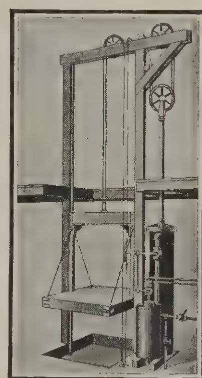

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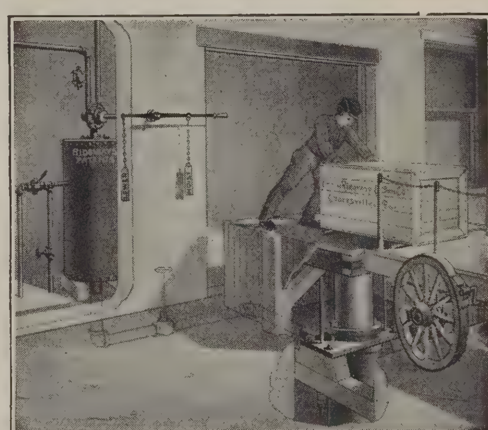

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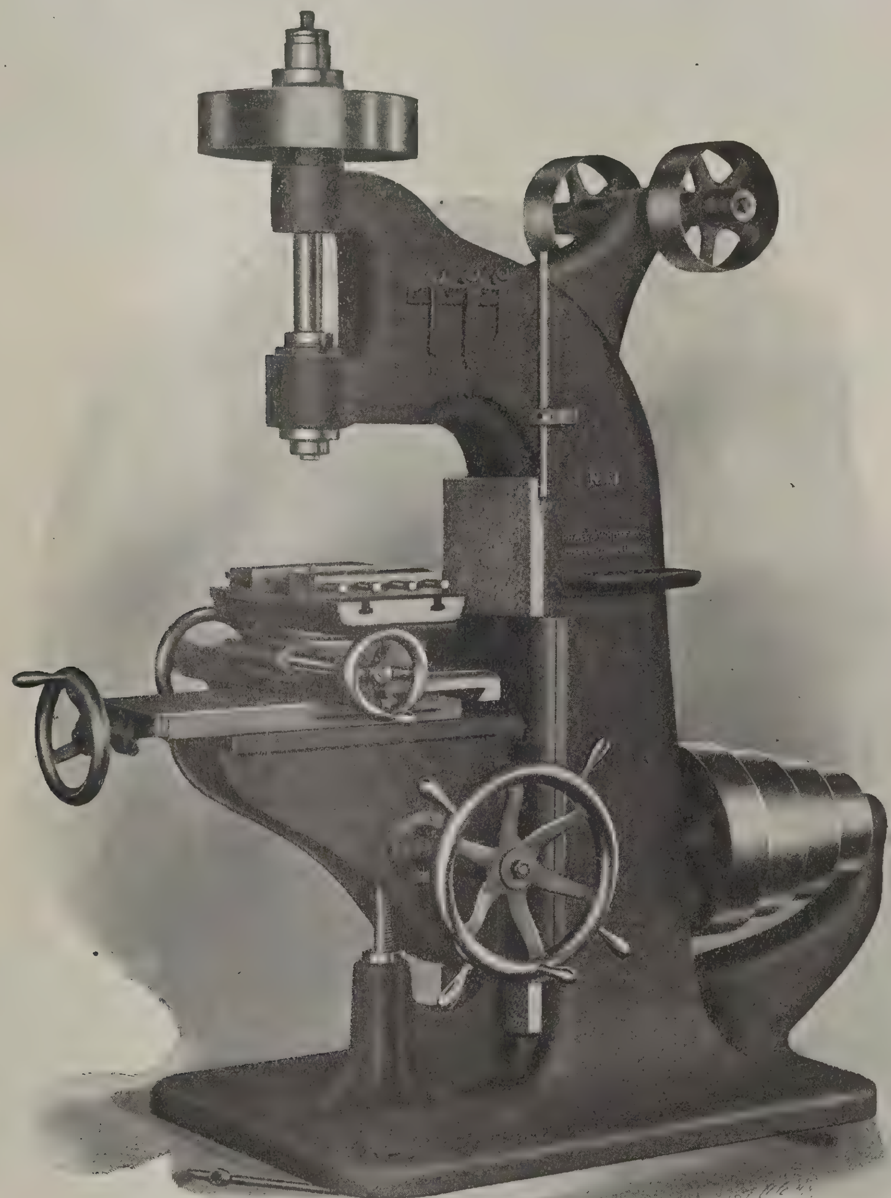

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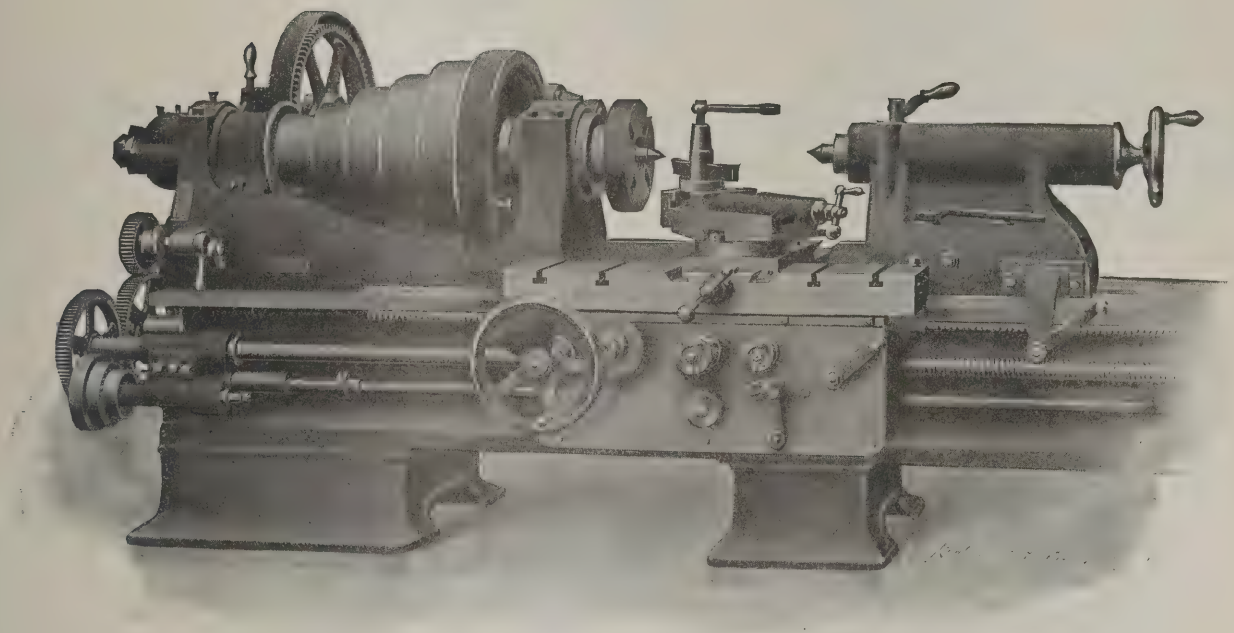

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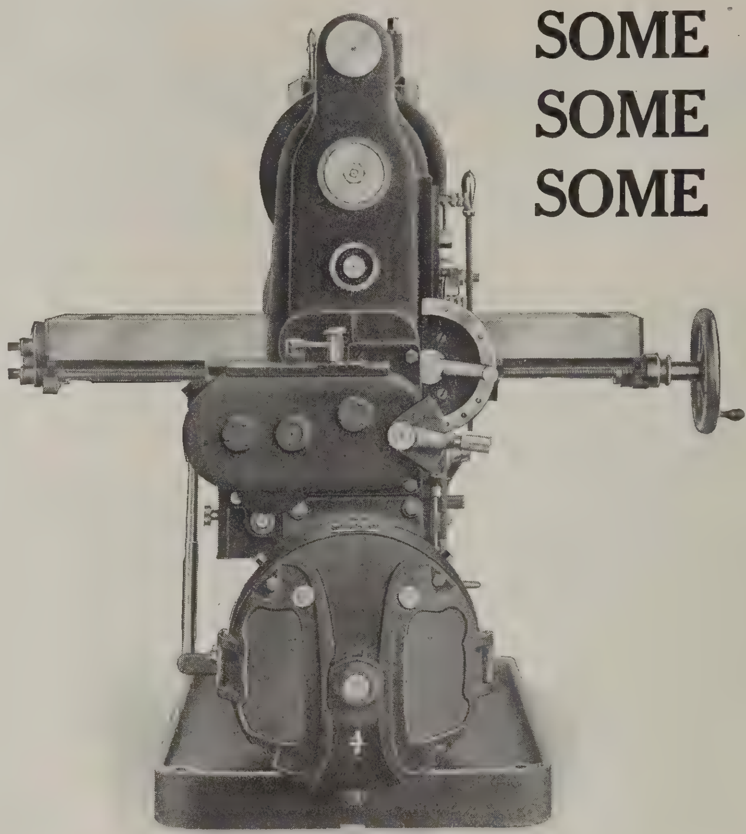

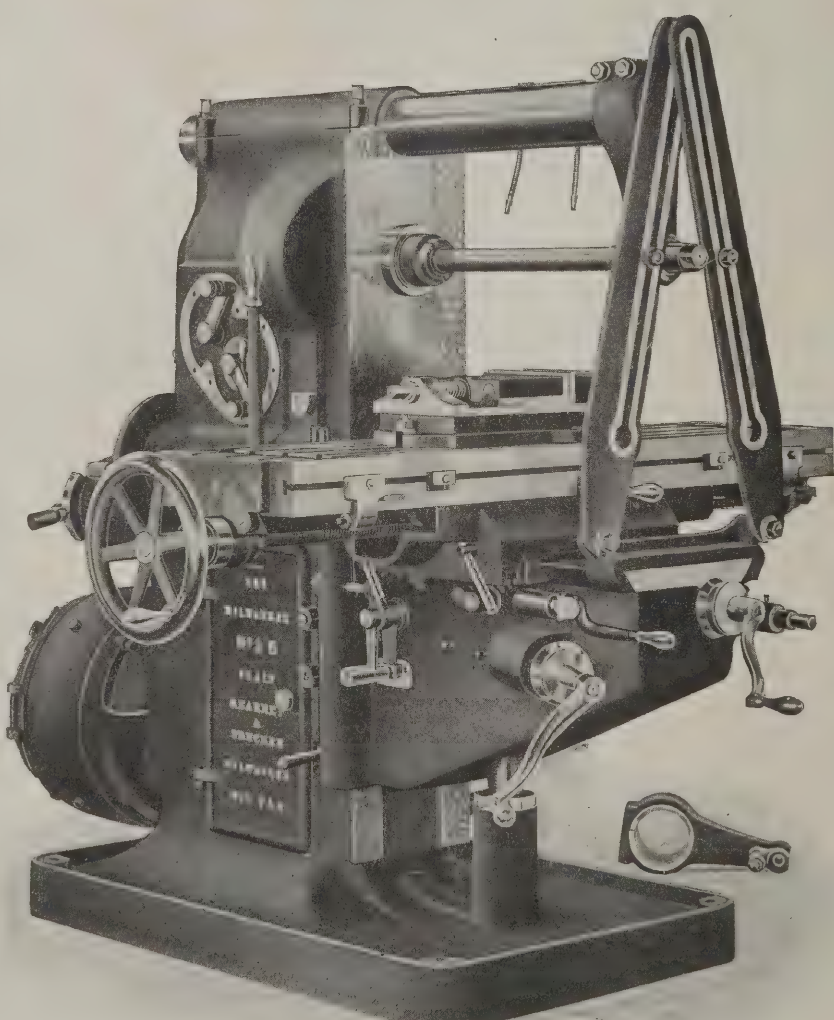

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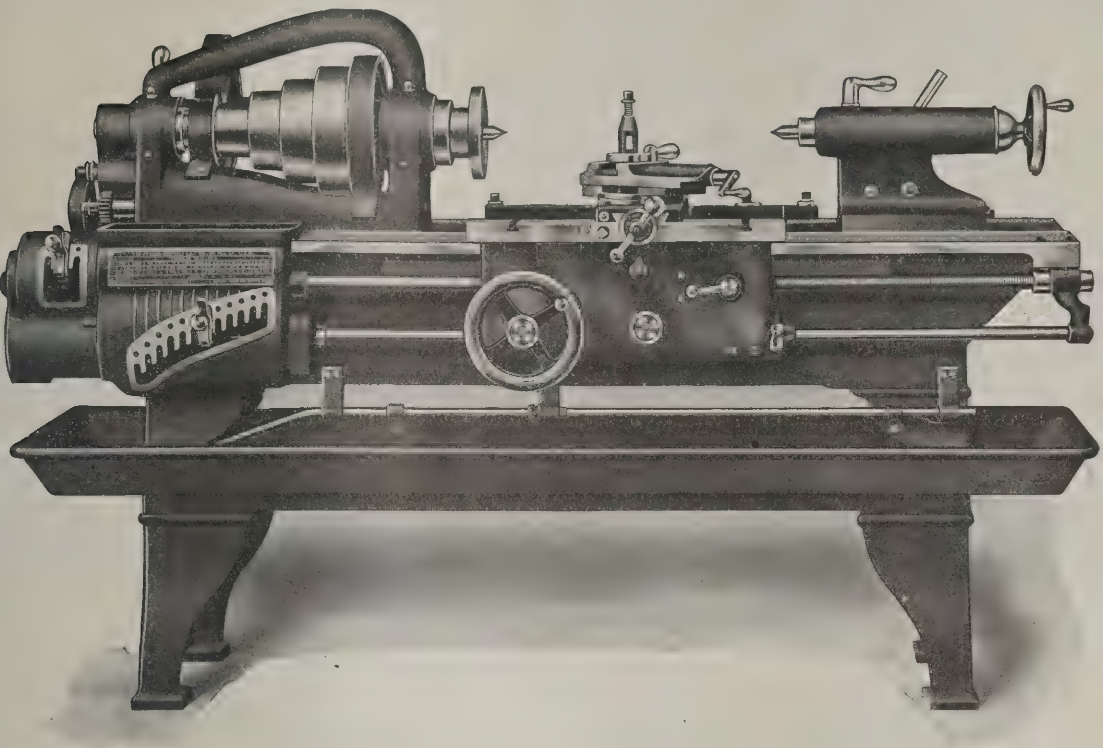

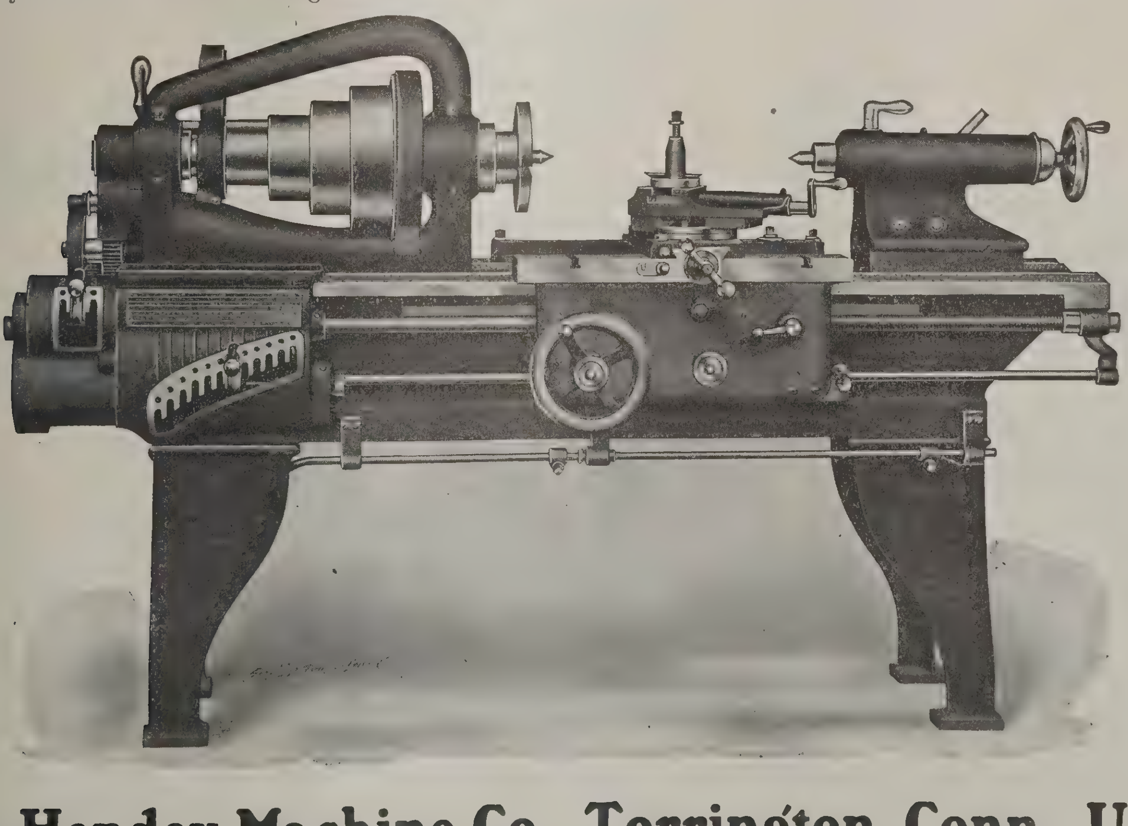

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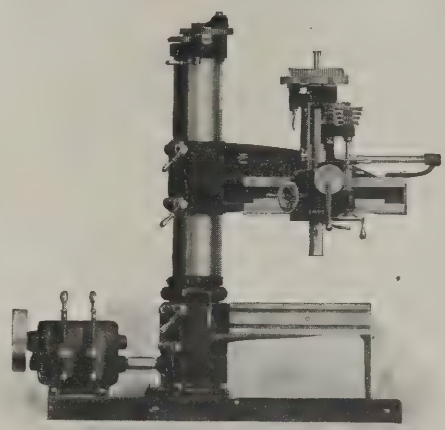

Plain: 2½ ft.—3 ft.—3½ ft. arm

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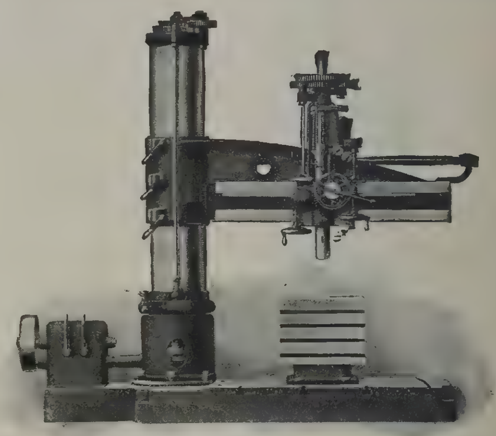

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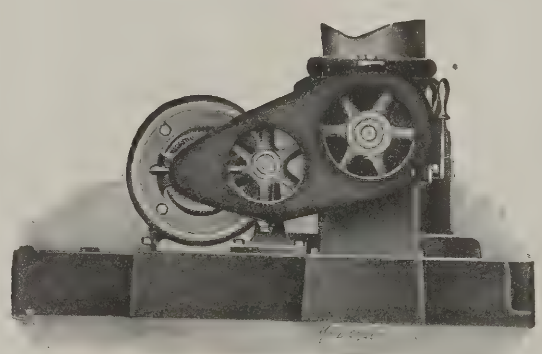

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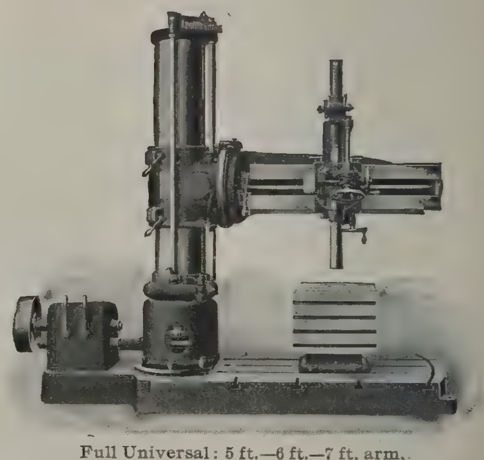

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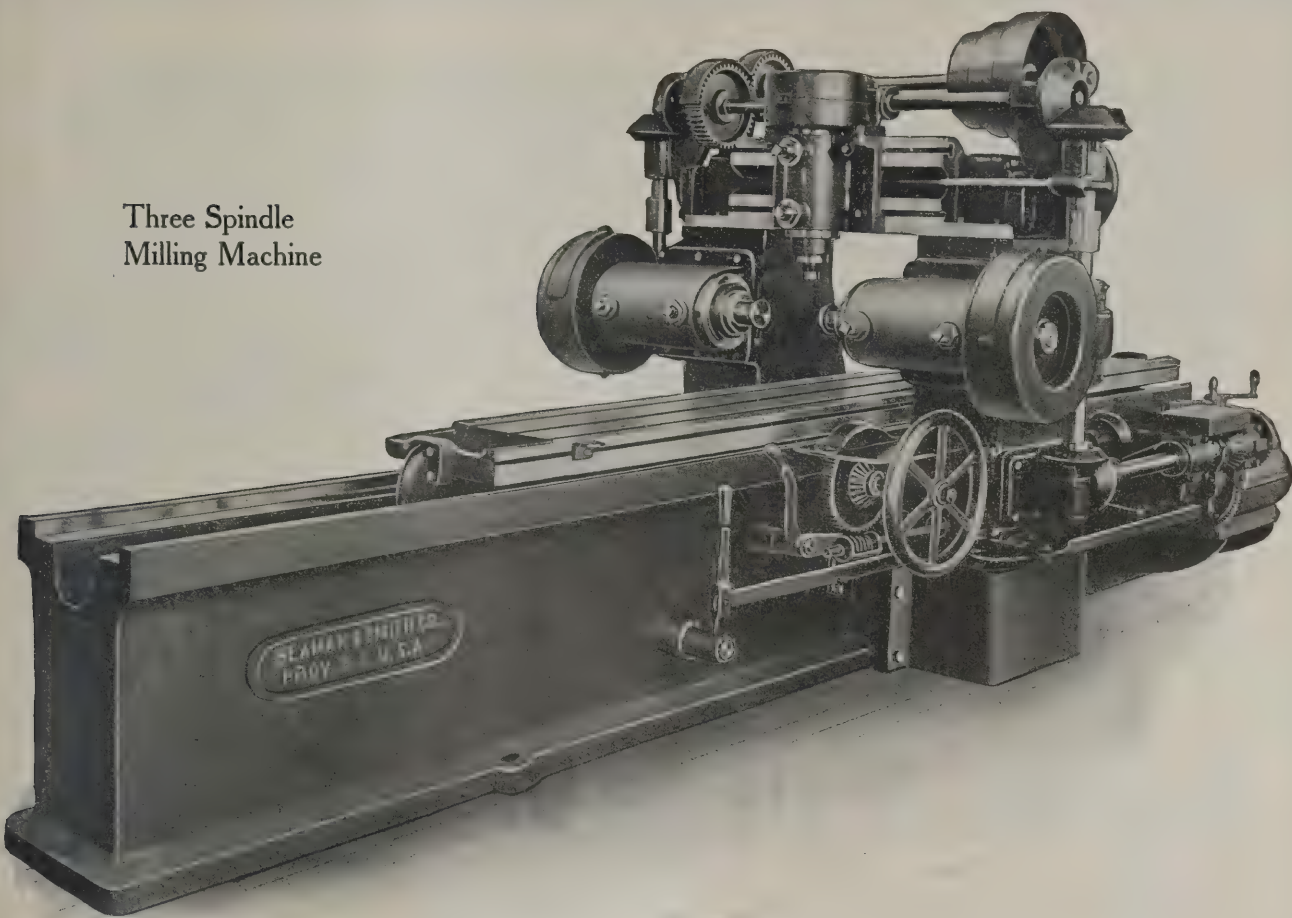

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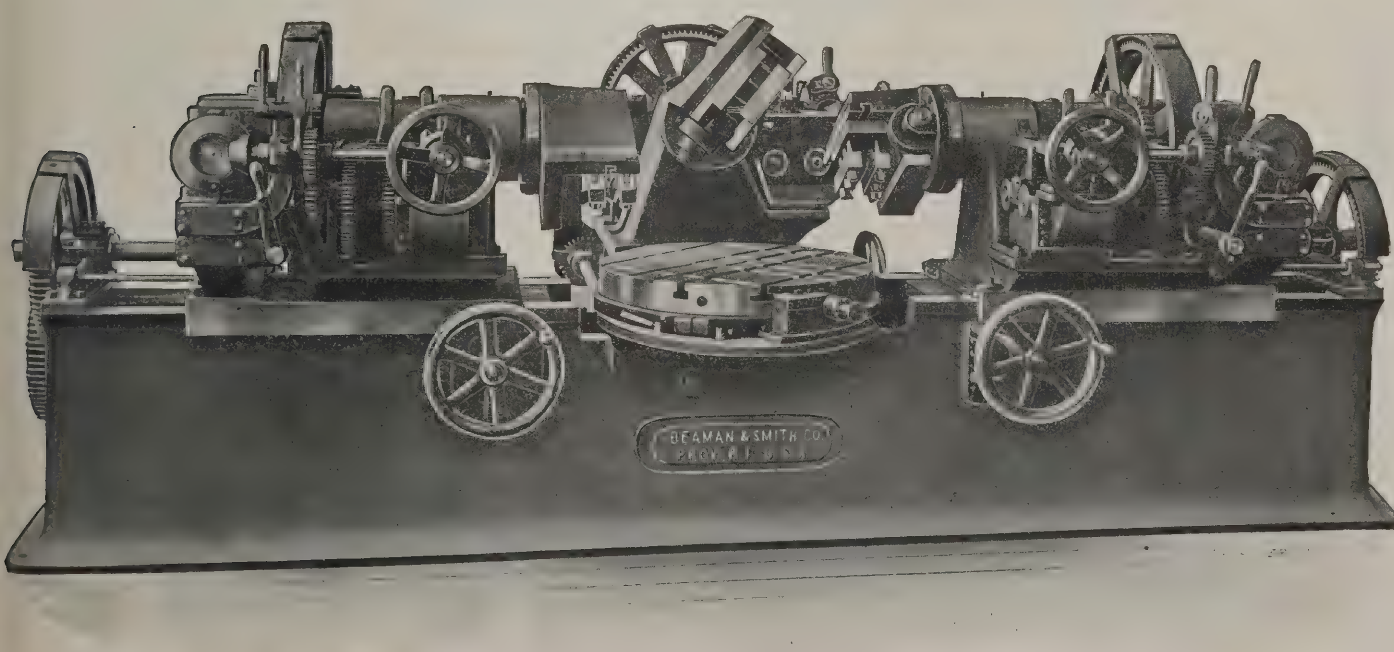

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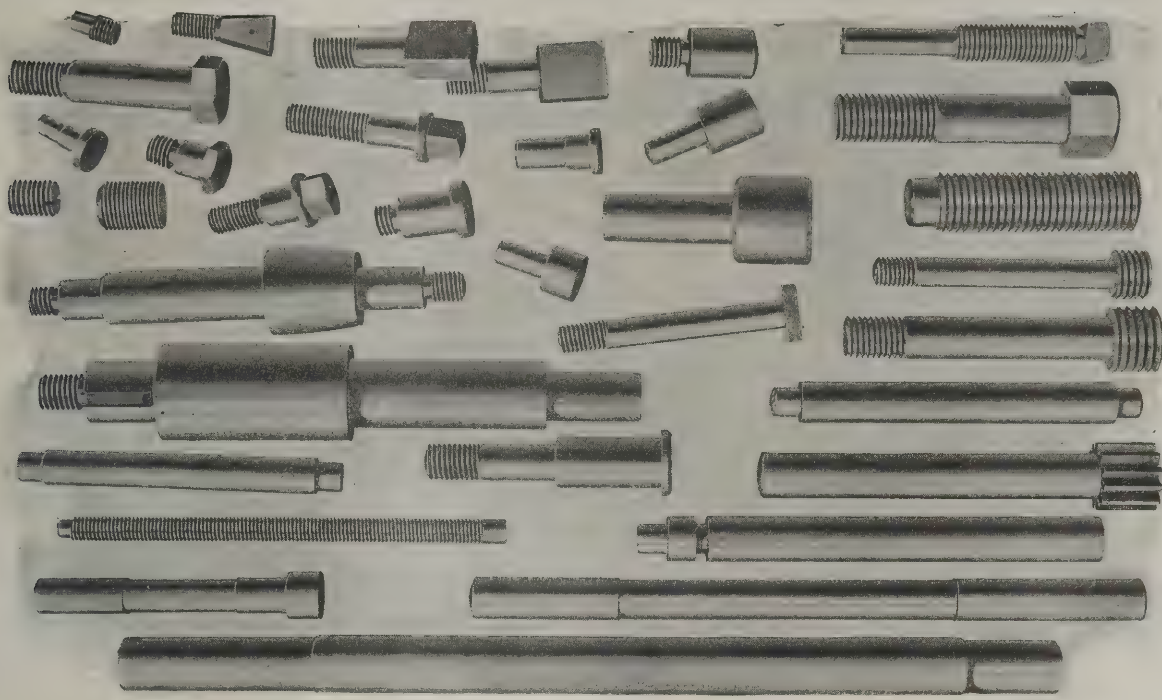

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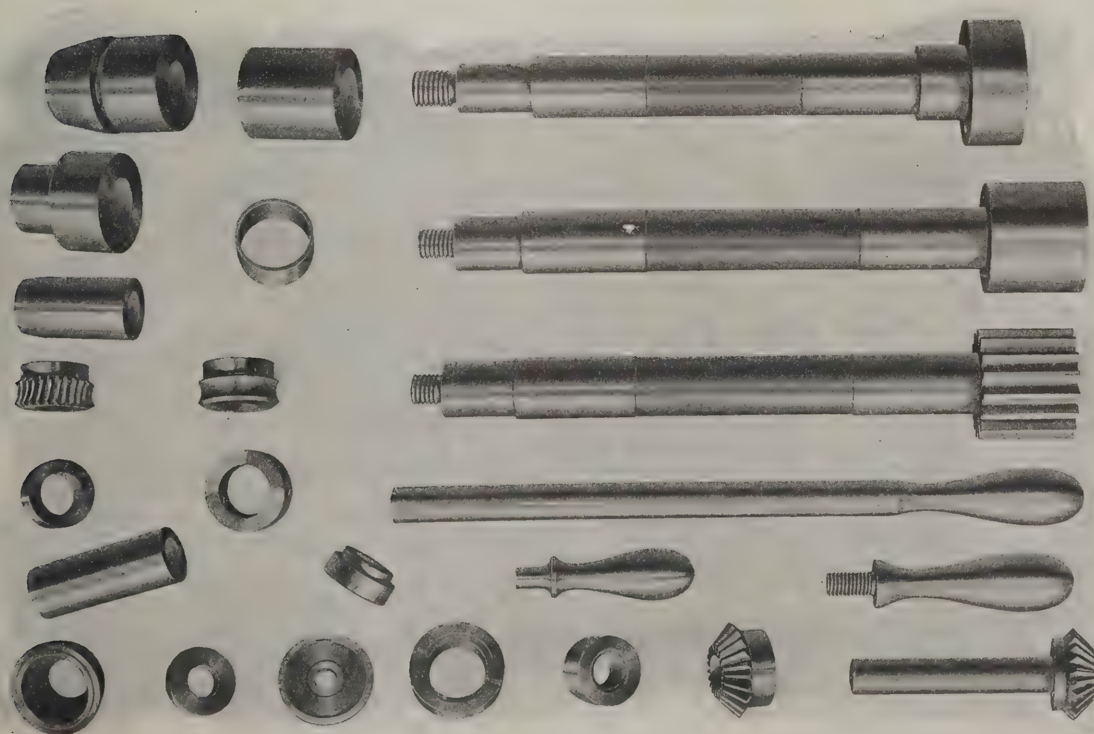

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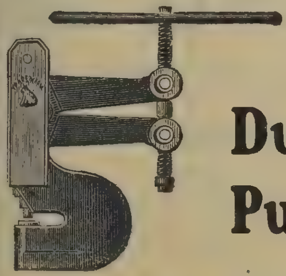

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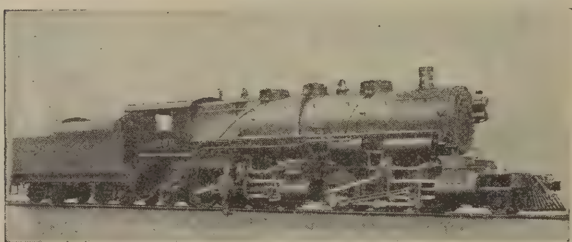

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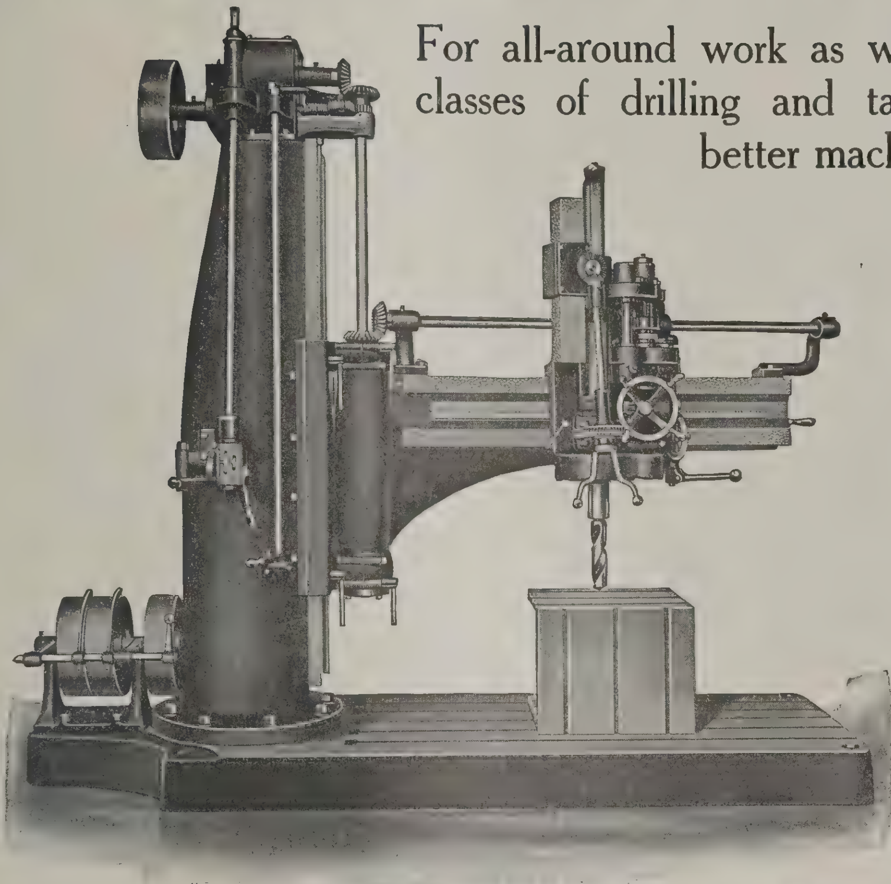

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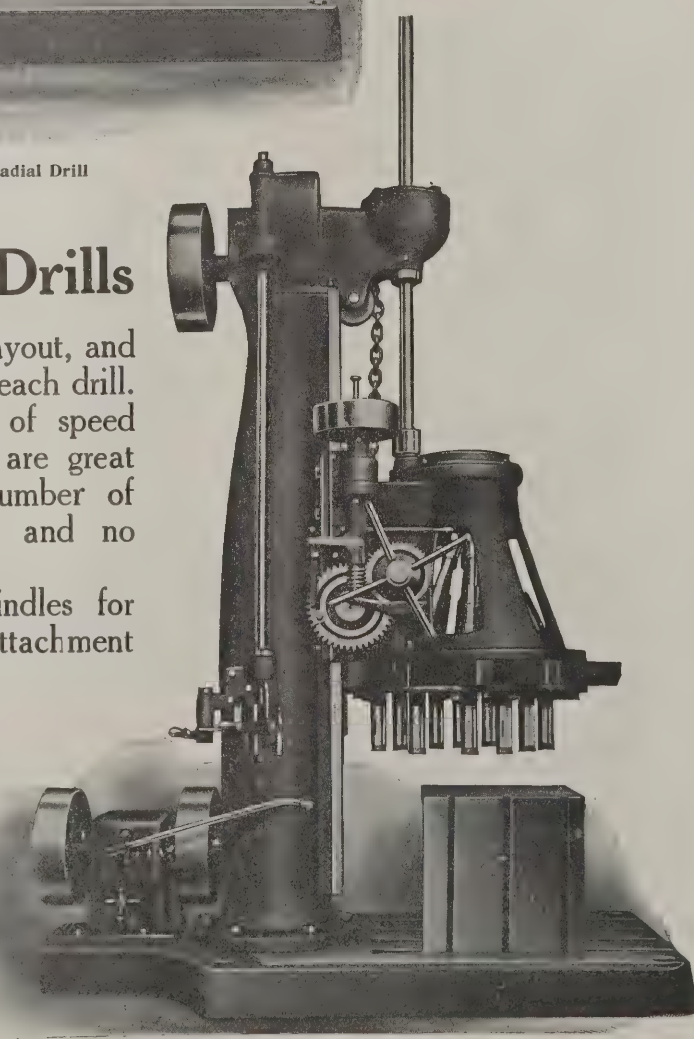

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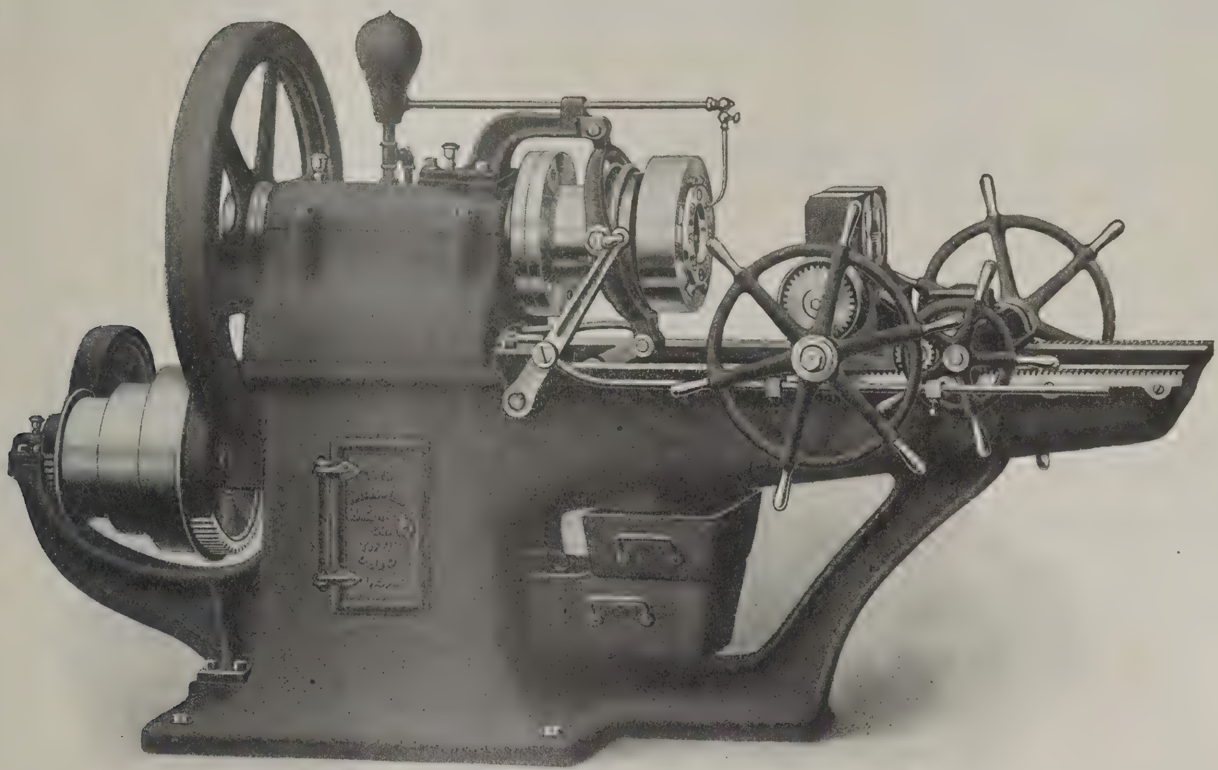

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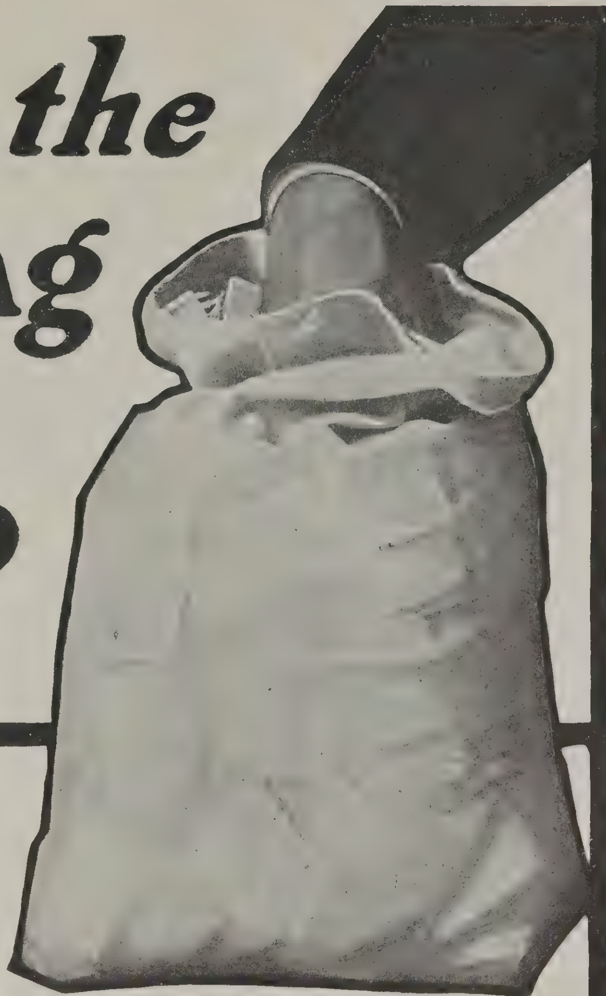

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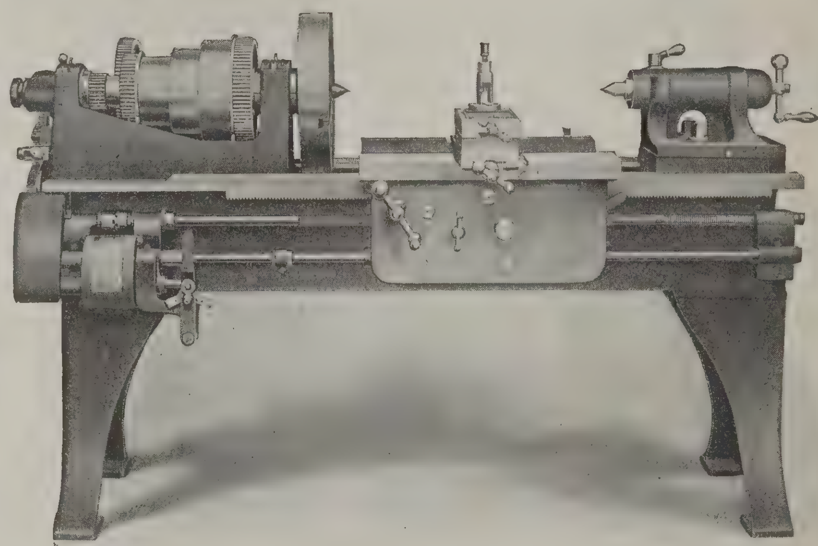

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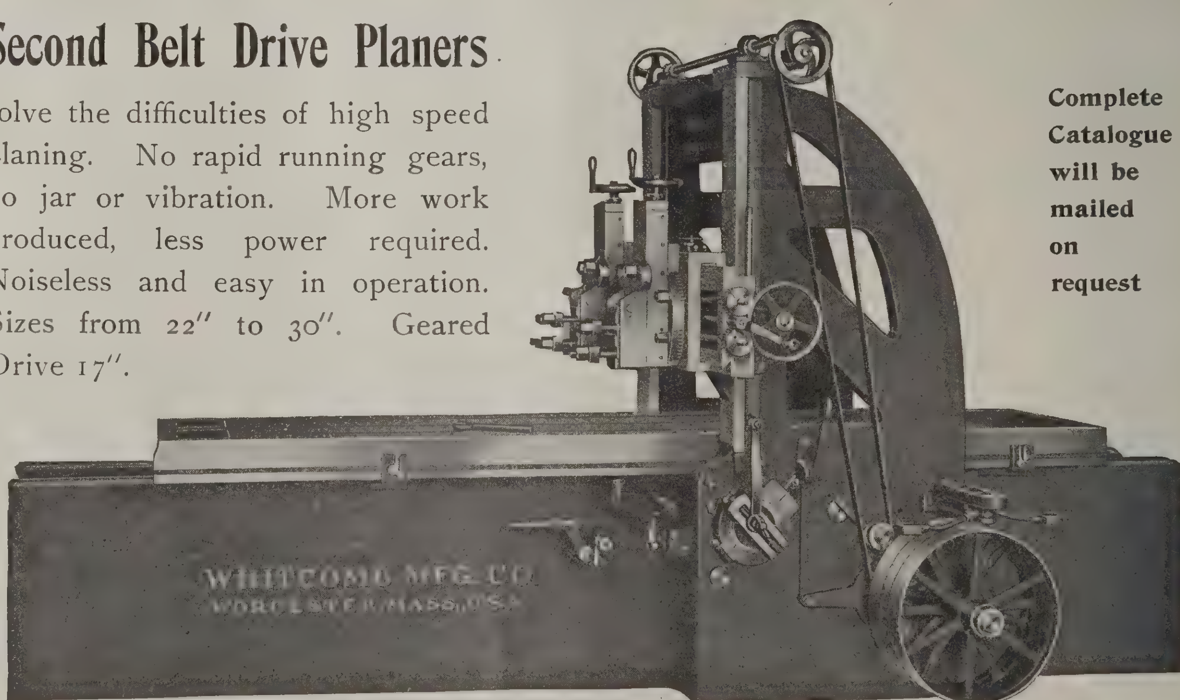

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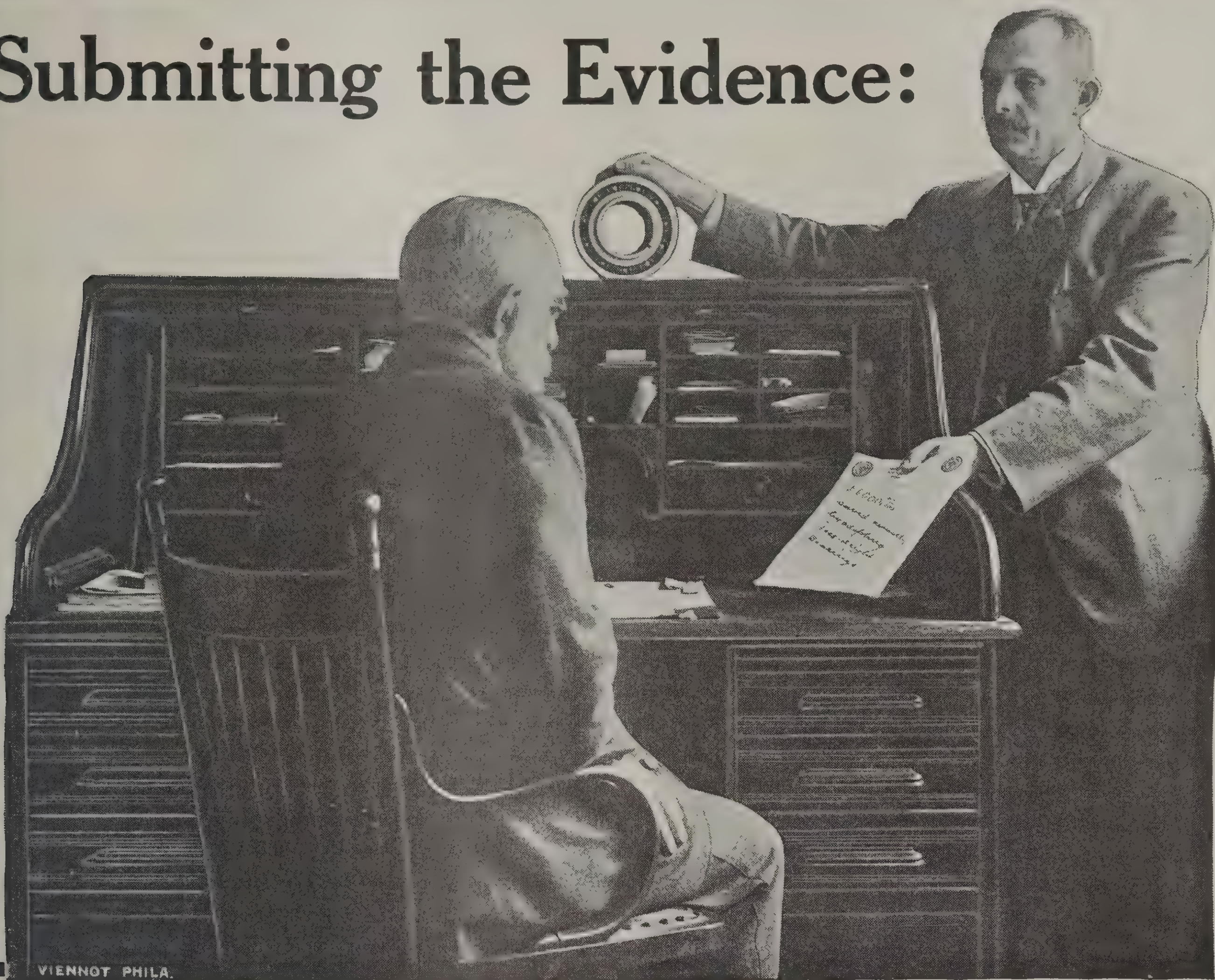

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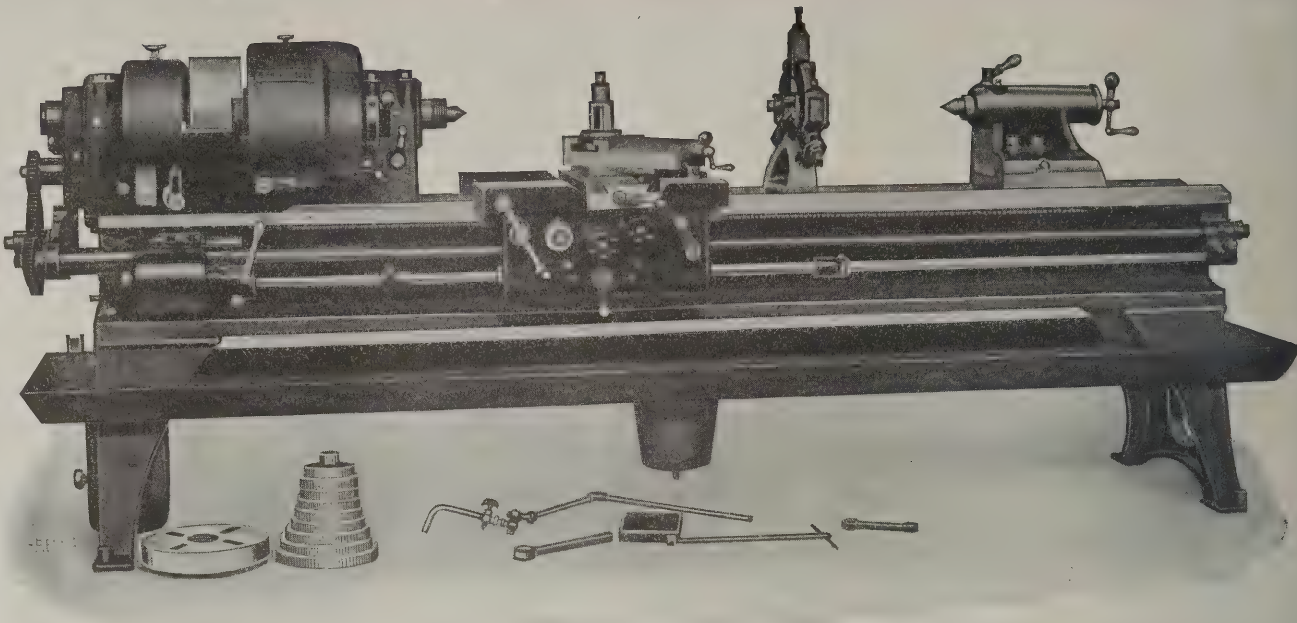

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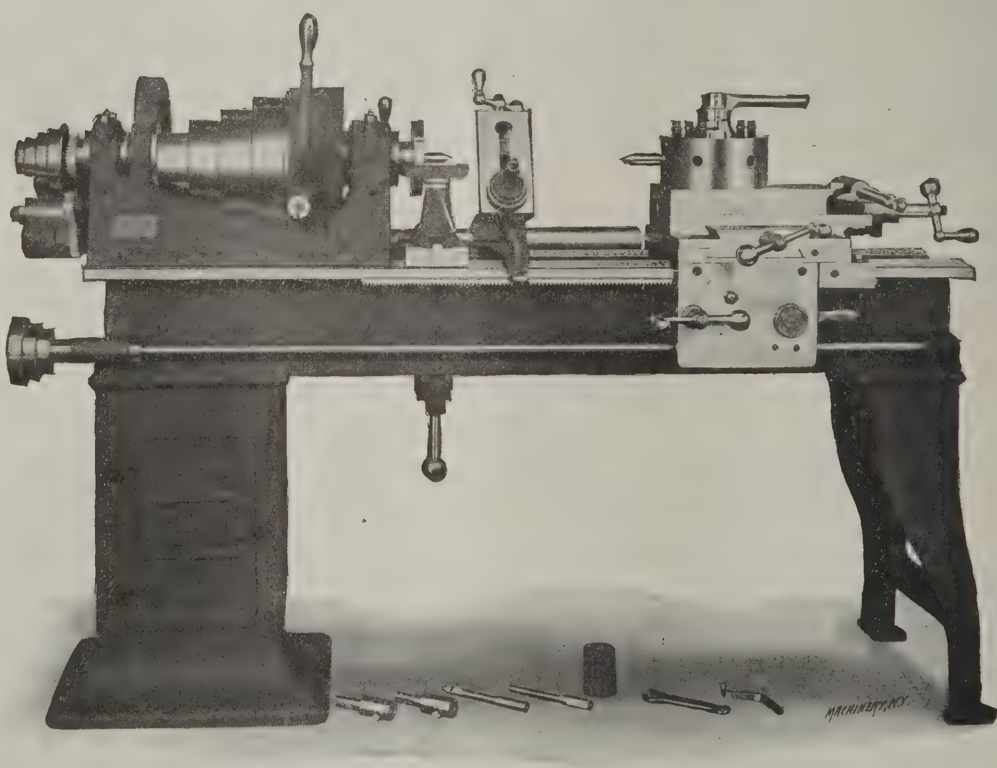

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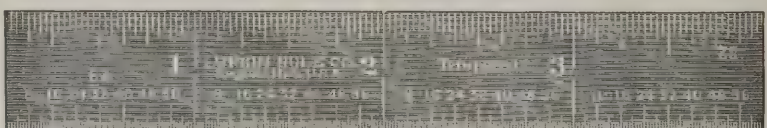

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Krips-Mason Mch. Co., Philadelphia, Pa.
Long & Allstatter Co., Hamilton, O.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Royersford Foundry & Mch. Co., Royersford, Pa.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Toledo Mch. & Tool Co., Toledo, O.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.
Watson-Stillman Co., New York.
Williams, White & Co., Moline, Ill.

Reamers.
Cleveland Twist Drill Co., Cleveland, O.
Morse Twist Drill & Mch. Co., New Bedford.
Pratt & Whitney Co., Hartford, Conn.
John M. Rogers Works, Gloucester City, N. J.
Schellenbach & Darling Tool Co., Cincinnati, O.
Standard Tool Co., Cleveland, O.
Three Rivers Tool Co., Three Rivers, Mich.
Van Dorn Electric & Mfg. Co., Cleveland, O.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Reamers, Adjustable.
Lapointe Machine Tool Co., Hudson, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers, John M., Works, Gloucester City, N. J.

Reamers, Pneumatic.
Independent Pneu. Tool Co., Chicago and N. Y.
Stow Flexible Shaft Co., Philadelphia, Pa.

Rivet and Spike Machinery.
National Mchy. Co., Tiffin, O.

Riveters.
Chambersburg Engineering Co., Chambersburg, Pa.
General Pneumatic Tool Co., Montour Falls, N. Y.
Grant Mfg. & Mch. Co., Bridgeport, Conn.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.

Roller Bearings.
Bantam Anti-Friction Co., Bantam, Conn.
Hess-Bright Mfg. Co., Philadelphia, Pa.

Saw Blades.
Diamond Saw & Stamping Wks., Buffalo, N. Y.
Massachusetts Saw Wks., Chicopee, Mass.
Millers Falls Co., New York.
West Haven Mfg. Co., New Haven, Conn.

For Alphabetical Index, see Page 36.

Classified Index to Advts. (Continued).

For Alphabetical Index, see Page 36.

CUT OUT AND FILE the three Shop Operation Sheets in this number. Your set may be worth a hundred dollars to you some day

Classified Index to Advts. (Continued).

For Alphabetical Index, see Page 36.

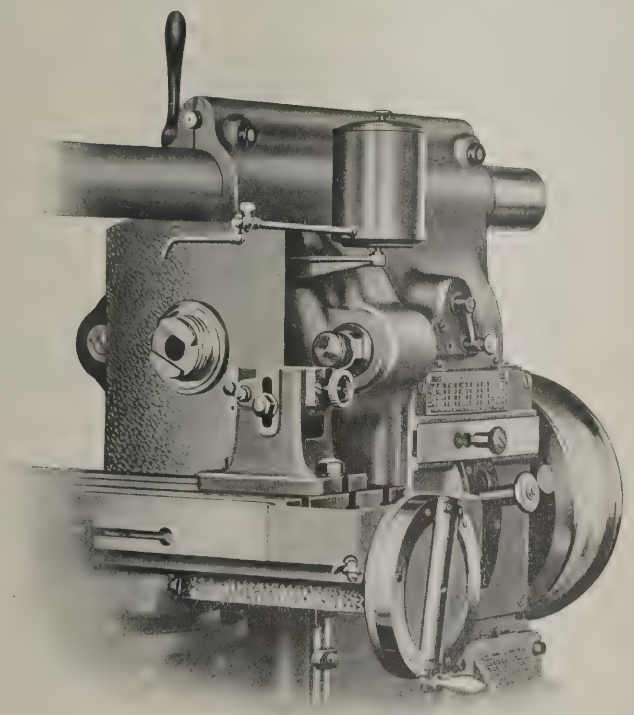
BROWN & SHARPE MFG. CO.

PROVIDENCE, R. I., U. S. A.

Why the Constant Speed Drive Milling Machine?

In order that an unvariable power for any given diameter of cutter on any spindle speed can be available.

How then can this Power be Obtained?



By means of a wide belt running at a high constant speed over a machine pulley of large diameter and a countershaft pulley of equal diameter. This gives large belt contact and high belt velocity, the **two requisites of Power.**

ADDITIONAL ADVANTAGES

No belts to shift. All changes of spindle speed made at the side of the machine by the simple adjustment of index slide and lever. Feeds independent of spindle speeds.

Detailed description and specifications of any of the Constant Speed Drive Milling Machines sent upon application.

MASTER BLACKSMITHS' ASSOCIATION CONVENTION.

The fifteenth annual convention of the International Railroad Master Blacksmiths' Association will be held at Bath Hotel, Montreal, Canada, August 20 to 22, inclusive. The subjects are: Flue Welding, John Connors, chairman; Tools and Formers for Bulldozers and Steam Hammers, G. M. Stewart, chairman; Piece Work, Grant Bollinger, chairman; Discipline and Classification of Work, S. Uren, chairman; Case-hardening Methods, Time Taken and Samples, Geo. Masser, chairman; Best Fuel for Use in Smith Shop, Joseph Jordon, chairman; Frame Making, Either Steel or Iron, Also Repairing Same, Grant Bollinger, chairman; Thermit Welding, Geo. Kelly, chairman; What Can Each Member do to Increase the Usefulness of the Association, G. F. Hinkens, chairman.

* * *

The world's automobile record was broken by Nazzaro in a Fiat car at Dieppe, France, July 2. He made an average speed of 70⅝ miles an hour for 6 hours 46½ minutes, the total distance traveled being 478½ miles.

* * *

FRESH FROM THE PRESS.

Proceedings of the American Water Works Association at the 26th annual convention held at Boston, Mass., July, 1906. 669 pages, 6 x 9 inches. Published by the secretary, John M. Diven, Charleston, S. C.

An Investigation of the Borides and Silicides. By Oliver P. Watts. 68 pages, 6 x 9 inches. Five pages of bibliography. Published by the University of Wisconsin, Madison, Wis. Price, 30 cents.

Locomotive Data. 90 pages, 3 x 5 inches, illustrated. Published by Burnham, Williams & Co., Philadelphia, Pa.

This little booklet, issued in the interest of the Baldwin Locomotive Works, gives in condensed form much valuable information on locomotives. The system of locomotive classification used by the Baldwin Locomotive Works is explained. The booklet contains diagrams of train resistance formula, grade resistance, curve resistance, tractive power of locomotives, both simple and compound, useful tables, etc.

Precision Grinding. By H. Darbyshire. 162 pages, 5½ x 8½ inches. 39 cuts. Published in the United States by the Hill Publishing Co., New York. Price, $2.

The work treats of the advantages of grinding, grinding wheels and their manufacture, methods of grinding compared, economy of grinding wheels and quality of finish, causes of defective work, the preparation of work for the grinding machine, plain cylindrical grinding, the universal head, plain surface grinding, cutter grinding, laps and lapping, measuring tools and gages, etc. The work is one that should be welcomed by the grinding machine operators and all who have to do with the use of the grinding machine.

Effect of Scale on Transmission of Heat Through Locomotive Boiler Tubes. By Edward C. Schmidt and John N. Snodgrass. 24 pages, 6 x 9 inches, illustrated. Published by the University of Illinois, Urbana, Ill.

This bulletin is No. 11, issued by the Engineering Experiment Station of the University of Illinois, and is an account of tests, extending over a period of years, made to determine the effect of scale on the transmission of heat in locomotive boilers, especially through the tube walls. These tests show that the effect of scale on heat transmission is extremely variable, and that it has been largely over-estimated in many cases. The tests show that the character of the scale is all-important and that mere thickness is not a measure of effect. The general conclusions are that with various thickness of scale up to ⅛ inch the loss in heat transmission may vary in individual cases from insignificant amounts to as much as 10 or 12 per cent; that the loss increases somewhat with the thickness of the scale; the mechanical structure of the scale is of as much or more importance than the thickness in affecting heat transmission; and that the chemical composition of the scale, except in so far as it affects the structure of the scale, has no direct influence on its heat-transmitting qualities.

NEW TRADE LITERATURE.

The United States Electrical Tool Co., Cincinnati, O. Catalogue of portable electrical tools, illustrating and giving specifications for portable drills, grinders, etc.

The Herman Pneumatic Machine Co., Zelienople, Pa. Catalogue of pneumatic molding machines, rotary sand sifters, pneumatic equipment for factories, etc.

Emmert Mfg. Co., Waynesboro, Pa. Catalogue No. 7, describing and illustrating Emmert patent universal vises. A price list for the different sizes is included.

Franklin Mfg. Co., 203 So. Geddes St., Syracuse, N. Y. Booklet entitled "Franklin Castings," describing the Franklin die cast process of producing small finished castings. A number of different styles of finished castings made by this method are illustrated.

Lumen Bearing Co., Buffalo, N. Y. Illustrated catalogue containing a comprehensive statement regarding the standard alloys produced by this company, the conditions under which they work most advantageously, and their limitations.

Niles-Bement-Pond Co., Trinity Building, 111 Broadway, New York City, in its *Progress Reporter* for July, 1907, gives information regarding the Pratt & Whitney 2 x 26 open turret lathe, 10-foot double rotary planing machine, Pratt & Whitney automatic grinding machines, Niles gantry crane, etc.

Tariff Series No. 3, being "Tariff on Machinery, Machine Tools and Vehicles," issued by the Department of Commerce and Labor, Washington, D. C. This compilation gives the tariff schedules of all countries imposing import duties on machinery, machine tools and vehicles.

Goldschmidt Thermit Co., 90 West St., New York. Pamphlet entitled "Thermit Steel for Welding," being an illustrated description of the thermit process for repairing broken parts of machinery. Several interesting examples of work repaired by thermit are illustrated and described.

Norton Co., Worcester, Mass. New 1907 edition of catalogue on Grinding Wheels and Machinery. This catalogue supersedes all previous editions and contains a comprehensive description of the products of the company. It also includes an account of the testing of the wheels, before shipment.

The R. K. Le Blond Machine Tool Co., 4605 Eastern Ave., Cincinnati, O. Catalogues on 20-inch High Speed Lathes, 24-inch High Speed Engine Lathe and Reducing Lathe, and Le Blond Turret Lathes and Equipments, respectively. These catalogues contain illustrations, specifications and general descriptions of the various types of these lathes.

Brown & Sharpe Mfg. Co., Providence, R. I. Booklet of gears, castings, and pumps, compiled with special reference to the needs of automobile manufacture. It illustrates hardened gears and various other varieties of gears for motor vehicle construction. The company makes gray iron castings, peculiarly well suited for air-cooled and water-cooled automobile cylinders.

Goldschmidt Thermit Co., 90 West St., New York. Pamphlet describing fire-brick molds for welding locomotive frames by the thermit process. These molds are now made in a variety of shapes to fit various parts of locomotive frames liable to fracture, and their use considerably simplifies the thermit process, as it eliminates much of the preliminary work in preparing a mold, which was necessary before.

American Spiral Pipe Works, Chicago, Ill. Catalogue of forged steel flanges, said to be the most complete work of its kind ever published on the subject. It contains illustrations of full size cross-sections of extra heavy hub flanges, extra heavy companion flanges, standard companion flanges, welding flanges, boiler flanges, tank flanges, riveted pipe flanges, A. S. M. E. standard riveted pipe flanges, riveted pipe manufacturers' standard; and the dimensions of extra heavy boiler flanges, double riveting boiler flanges, etc.

Ingersoll-Rand Co., 11 Broadway, New York City. Bulletin on "Crown" Pneumatic Hammers. These hammers are fully described, each detail of construction being shown, and every operation given attention. The design of the hammer is new and the construction simple. Five sizes of hammers are made for chipping, calking, scaling, flue-beading, etc., and four sizes, long stroke, for driving rivets from the smallest up to 1⅜-inch diameter. The bulletin also describes a displacement air meter, by which the performances of these tools have been tested and verified.

Union Twist Drill Co., Athol, Mass. Illustrated book of information on gear and milling cutters. Cutters for gear wheels, twist drills, taps, reamers and formed cutters, which can be sharpened without changing the form, are listed; also milling cutters, metal slitting saws, angular cutters, end mills, screw slotting cutters, inserted tooth cutters, etc. The book contains full-size diagrams of involute gear teeth from 20 diametral pitch to 1 diametral pitch, inclusive, formulas in gearing, valuable tables, directions for grinding cutters, etc. Mechanics will find it an indispensable work of reference for the machine shop.

The McConway & Torley Co., Pittsburg, Pa. Pamphlet entitled "Car Repairman's Guide," being a list of the repair parts required for the Janney, Kelso and Pitt freight couplers, and the Buhoup three-stem equipment for passenger cars. The company calls the attention of railway officials to the desirability of ordering repair parts from the manufacturer of the used couplers. A great deal of unnecessary trouble and delay in making repairs is caused by attempts to use repair parts that were not made by the manufacturer, and which are frequently incorrect to pattern and inferior in material or workmanship. The object of this pamphlet is to place definite information in the hands of the men so that the proper repair parts may be secured.

MANUFACTURERS' NOTES.

Brown & Sharpe Mfg. Co., Providence, R. I., will close its works for the regular annual vacation from August 2 to August 12. During the vacation the offices will be open as usual.

The Pittsburg Automatic Vise and Tool Co., Pittsburg, Pa., recently shipped a number of the largest vises ever constructed to the Portsmouth Navy Yard, N. H. These vises weigh 695 pounds each, and are specially designed for heavy and severe service.

Carnegie Technical Schools, Pittsburg, Pa., report that their department of mechanical engineering practice is starting a catalogue file, and they request manufacturers to send their catalogues in care of Prof. Trinks. Complete information is desired on all lines of mechanical work, from boilers and engines to automatic and special machinery.

Independent Pneumatic Tool Co., First National Bank Building, Chicago, Ill., reports that its business has shown a remarkable increase over the corresponding period of last year. Its Aurora, Ill., plant has been enlarged, the capacity being increased about 50 per cent. The plant is now running in full operation day and night, and sufficient orders are on hand to keep the plant running for several months.

Crocker-Wheeler Co., Ampere, N. J., announces that on account of the large volume of business in electric generators and motors in southern Ohio, it has been found necessary for the Cleveland office to open a sub-office in the Columbus Savings and Trust Co. building, Columbus, Ohio. The sub-office will be in charge of Charles W. Cross, formerly of the Cleveland office.

The Cincinnati Planer Co., Cincinnati, O., has increased its capital stock from $200,000 to $400,000. The additional capital will be used to cover the cost of the new plant now being built at Oakley, Ohio, which is a suburb of Cincinnati. This plant will be equipped complete with new machinery, and will be operated exclusively on large planers from 6 to 12 feet square. The company will continue to operate its present plant on the smaller sizes. The new Oakley plant is now well under way, and will be completed some time in September.

Lumen Bearing Company, Buffalo, N. Y., is erecting a two-story building 125 x 30 feet, to be used for the storage and manufacturing of wooden patterns, and as a carpenter shop. This building is connected by a passageway with the main foundry, and is of fireproof construction, steel and concrete only being used. The windows are of wire glass and the door cases are made of pressed steel. This addition will greatly facilitate the company's work, as it gives them a storage capacity for 50,000 patterns of the ordinary run for brass foundry work.

A new engineering society has been organized in Philadelphia called The Engineers' and Constructors' Club. The membership is limited to the engineers composing the organization of Dodge & Day. The officers are Harold T. Moore, president; George Walters, secretary; F. C. Andrews, H. F. Sanville, John E. Zimmerman, C. N. Lauer, managers. The object of the club is to discuss subjects relating to engineering and construction, and to give all the members the benefit of the experience gained by each in his particular line of work. The proceedings of the club will be published regularly.

American Blower Co., Detroit, Mich., made an exhibit at the recent Atlantic City convention of the Master Mechanics and Master Car Builders Associations, which attracted much attention. It consisted of an American high-pressure blower in operation, emitting from the discharge a blast of air at high velocity, which held suspended about four feet above the outlet a ball of 12 inches diameter. Just why the ball remained at that point instead of flying off into the ocean was a question that puzzled the crowd. Those who are interested in the answer should write the company for an explanation.

In view of the present interest in transportation problems, the article in the August *Century* entitled "The Waterways of America" is a very timely one. The author, Charles D. Stewart, has an inti-

CONTENTS FOR AUGUST.

mate acquaintance with the Mississippi and Missouri, and he gives a well-written review of the past and present of our great inland thoroughfares, as well as of their possibilities. Of no less general interest than this article is one by Jesse Lynch Williams, "The Gates of the City," which has been made the leading article of the issue. The author gives a vivid picture of the life and color, the comedy and tragedy of the railway stations in our great cities.

The new Machinery Club, organized in New York by those interested in the various branches of the machinery and metal trades, is making satisfactory progress, and has engaged quarters on the 20th and 21st floors of the Fulton Terminal Building, on Church St. The space provided for the club is 36,000 square feet, and there is a possibility that the 19th floor of the building also will be reserved, in which case the total area available will be 54,000 square feet. The organization will be primarily a lunch club, but it is expected that the conveniences of the location and the home-like appointments will make it a general rendezvous of the machinery trade in New York. Resident membership will be limited to 750, and will consist of members residing in Manhattan or having a regular office there. The suburban membership will be limited to 500, and will be confined to those having a regular office outside of Manhattan, but within fifteen miles of New York City Hall. The non-resident members, limited to 1,000, will be those residing or having a regular office outside of the suburban membership limits. No limit is placed on the number of commissioned officers of the Army and Navy, either active or retired. The membership committee is J. R. Vandyck, chairman; George L. Gillen and Charles H. Crook. The temporary quarters of the Machinery Club are at 26 Cortlandt St., New York.

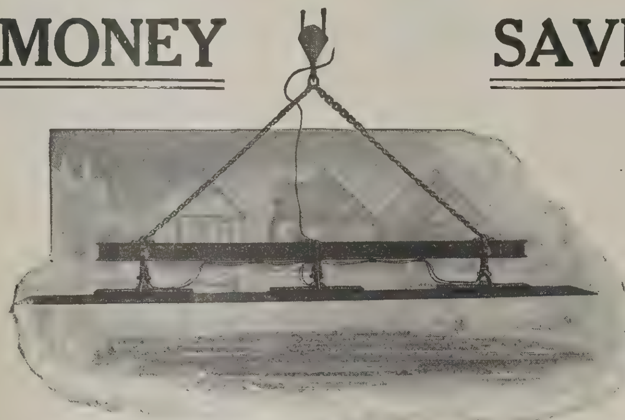
MISCELLANEOUS.

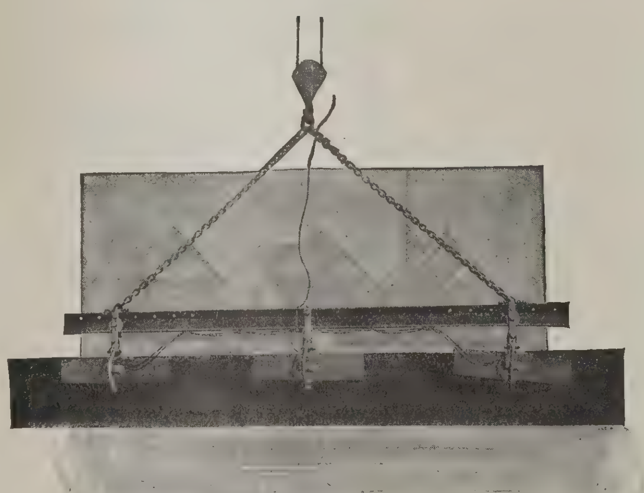
LIFTING MAGNETS

SAVE MONEY   SAVE TIME

The cuts shown herewith illustrate three of our Type F-5 Magnets attached to a spreader, used to transport ship plate ¼ to 1 inch thick, 8 ft. wide and 40 feet long from the horizontal position on the dock to vertical position at the side of the of the ship where it is to be riveted.

Equipments of this type have also demonstrated their value in unloading plates from a horizontal position in a car and transferring them to a vertical position in stocking racks.





Magnets pay for themselves within three to five months from date of installation. *Send for Catalogue.*

We also manufacture other types of magnets for handling all classes of magnetic material such as pig iron, crop ends, rail ends, bolts, nuts, rivets and all miscellaneous melting stock.

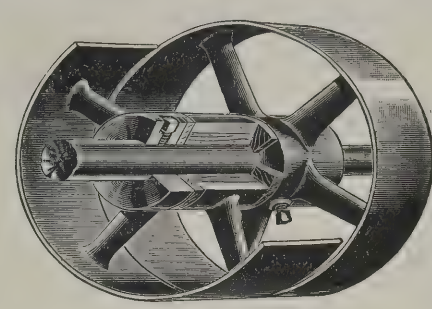
When lifting magnets are used no labor is required other than the crane operator.

Car loads of scrap are unloaded with despatch impossible by any other known method and transferred to stock pile or charging boxes direct.

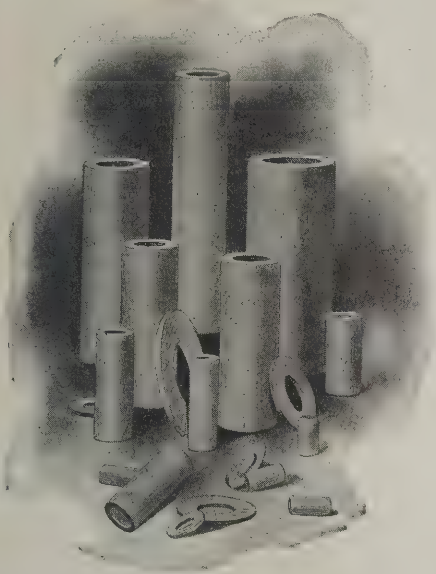
The
Electric Controller & Supply Co.
Cleveland, Ohio.

ONE of the meanest of Machinery Problems is how to Lubricate the Loose pulleys.

It has to be done, yet oil won't stay at the center of a rapid running loose pulley—it's thrown off as quick, or quicker than you can put it on, and then there's all kinds of trouble.



Loose Pulley Equipment
PATENTED



Standard Cylindrical Bushings and Thrust Washers

Arguto Oilless Bearings

permit loose pulleys and friction clutches to be run absolutely without oil or other lubricant. They are the *solution of the problem,* wear indefinitely, require no attention and have proved their worth in the largest and most progressive plants in the country. Arguto Oilless Bearings will eventually be specified with every order for loose pulleys or friction clutches—why not get in line now? *Booklet for the asking.*

ARGUTO OILLESS BEARING COMPANY
WAYNE JUNCTION, PHILADELPHIA, PA.

See our Exhibit, Section 6, Machinery and Transportation Building, Jamestown Exposition.

"Arguto"
TRADE MARK
Reg. U. S. Pat. Of.

Can You File a Blanking Die

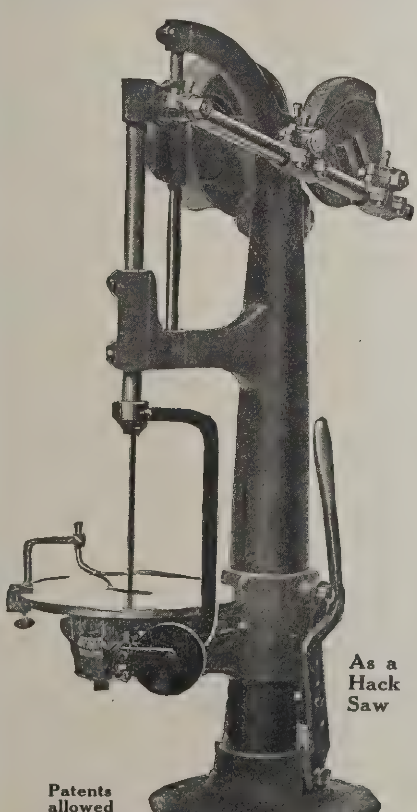
by hand with ONE DEGREE of clearance and have it so accurate that the blanks will fall out as soon as they are cut free?

We are doing it with the "SIMPLEX" Filing Machine, and in ONE-HALF the time required to file dies with x degrees of clearance by hand.

The "ONE DEGREE" die can be ground repeatedly—

How many times can the ordinary hand filed die be ground?

Consider this matter. It means DOLLARS TO YOU, both in first cost of dies and in their increased life.



As a Hack Saw

Patents allowed

We shall be glad to send a list of firms who "have discovered" the Simplex Combination Bench Filer and Hack Saw, if you will let us know your address.

As a Filing Machine

Patents allowed

The Simplex Manufacturing Company
90 WEST STREET, NEW YORK CITY

The Advantage is Yours

By adopting the Graham Chuck and the Graham Grooved Shank System of tools you stand to save 10% per cent. in time and 100% on your chuck bill. Isn't this an advantage?

The Graham Chuck

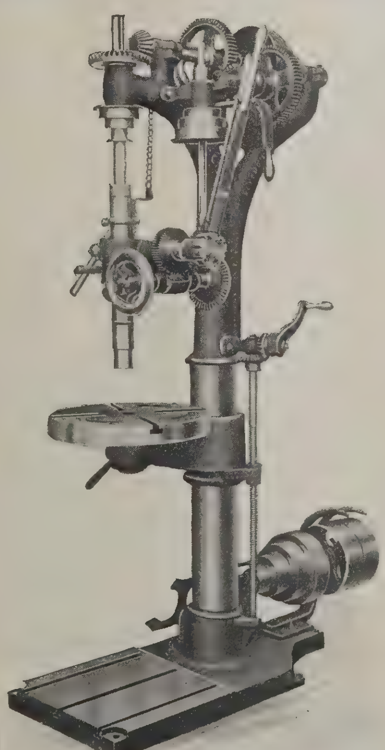
holds the tools so there is no danger of slipping or working loose. A single turn of the sleeve tightens or releases the tool—no wrench, screw or hammer required. It is strong and durable, can be made to fit the spindle of any drill press or lathe, and one chuck, with reducers, holds a complete range of sizes from 3/32" to 2½"—drills, taps, reamers, etc.

New Catalogue on request

Detroit Twist Drill Co.
630-646 Fort Street, West
DETROIT, MICH.
Manufacturers of all kinds of Twist Drills, Reamers and Special Tools

THERE'S A PLACE FOR THIS DRILL IN YOUR SHOP

The design is new. All improvements incorporated. Drills to the center of a 21-inch circle and is quick and accurate in operation.



We shall be glad to send you a special circular of the 21-inch Back Gear Power Feed Drill if you will write us.

SUPERIOR MACHINE TOOL CO.
Kokomo, Indiana

REGISTERED
GLYCO GLYCO GLYCO
TRADE GLYCO MARK

THE BEST BEARING METAL FOR ALL PURPOSES

GLYCO

CHEAPER AND BETTER

THAN THE HIGH PRICED TIN ALLOYS

HOMOGENEOUS
UNIFORM NEVER-CHANGING

A LARGE STOCK ALWAYS ON HAND FOR IMMEDIATE SHIPMENT

ASK FOR GLYCO BOOK—JUST PUBLISHED

AMERICAN GLYCO METAL CO.

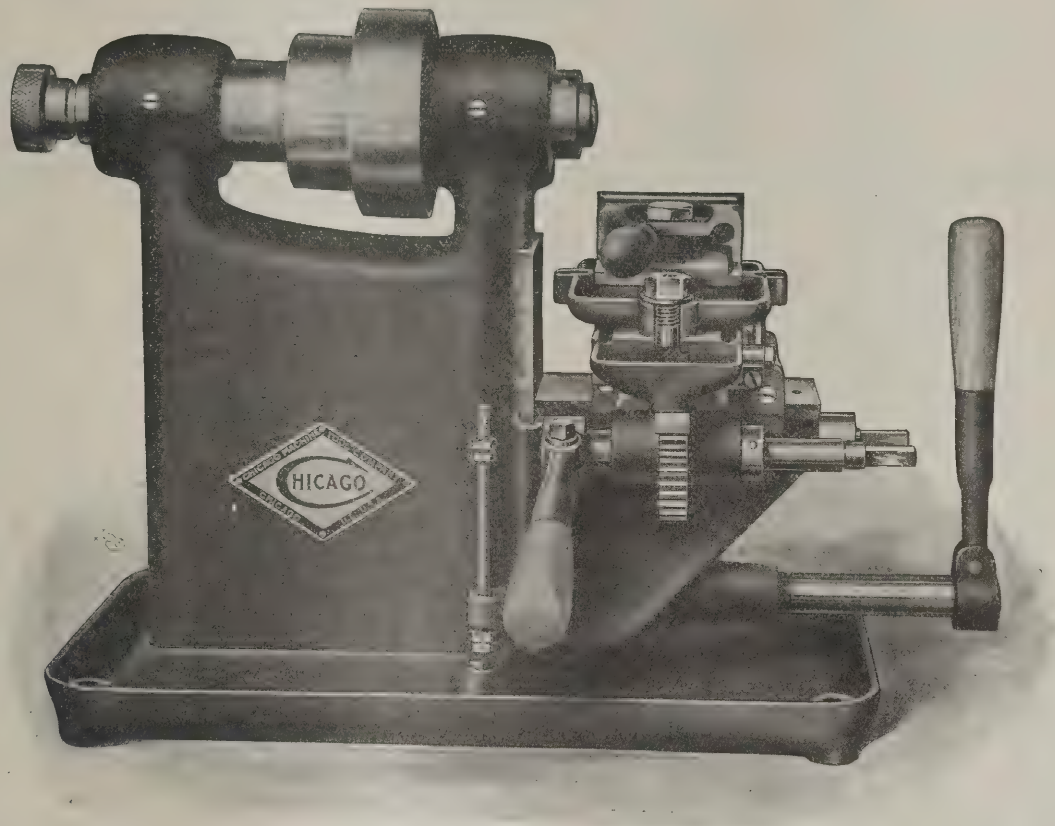
SOLE MANUFACTURERS IN AMERICA OF

GLYCO METAL
AND
GLYCO PATENTED SKELETON BEARINGS

JOSEPH T. RYERSON & SON

CHICAGO NEW YORK PITTSBURG
GENERAL DISTRIBUTORS

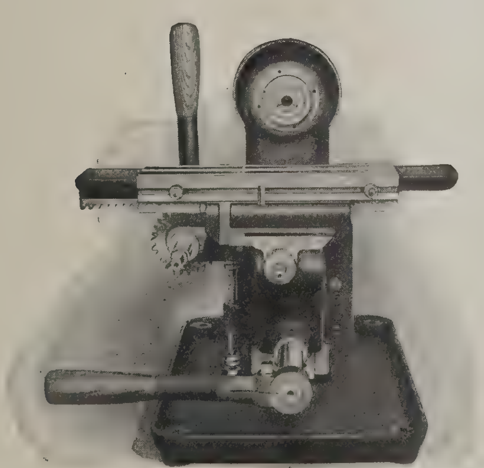
New Bench Milling Machine

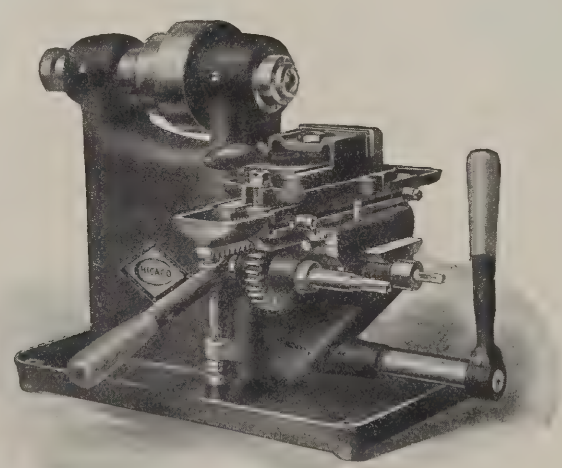


We are pleased to call your attention to these different views of our New Bench Miller

The Chicago Machine Tool Company

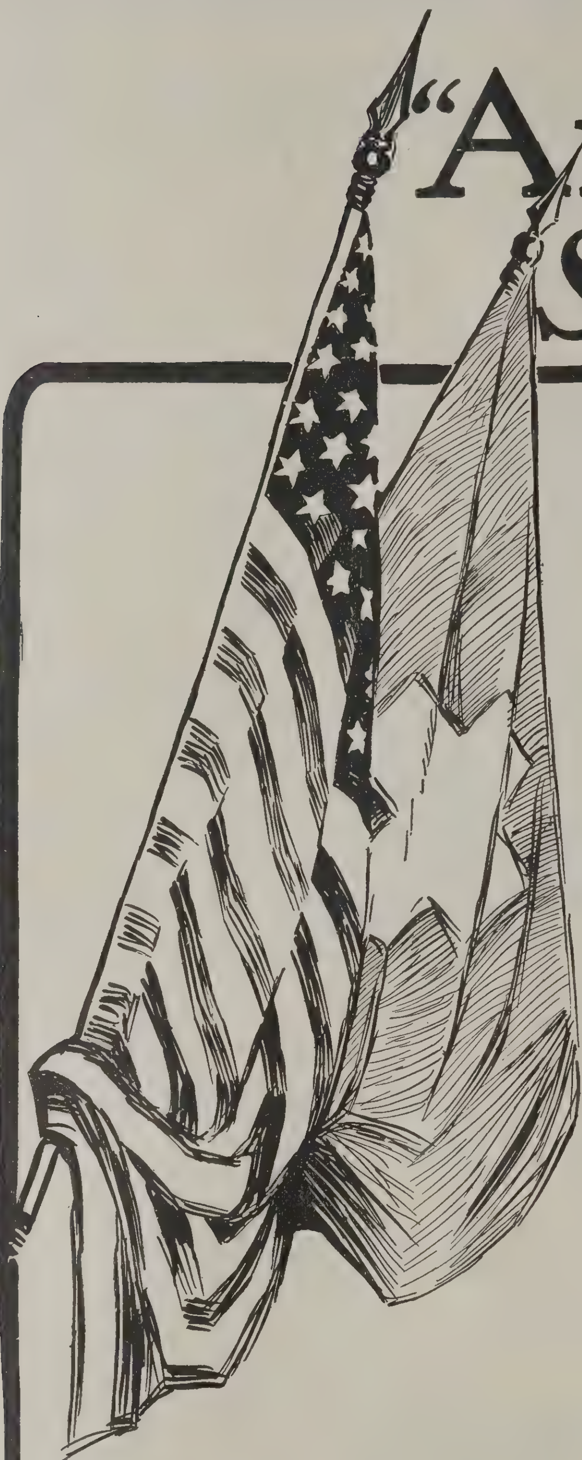
CHICAGO, ILLINOIS





DOMESTIC AGENTS: Hill, Clarke & Co., Inc., Boston, New York, Chicago, Philadelphia

FOREIGN AGENTS: A. H. Schutte, Paris, Brussels, Milan, Cologne, Barcelona; Schuchardt & Schutte, Berlin and Vienna
Chas. Churchill & Co., London, Manchester, Glasgow and Birmingham



"American Swiss" Files

We are pleased to announce that

Our New File Works

are in perfect working order,
and their constantly increasing output of

"American Swiss" Files

will enable us to abolish the Waiting Lists
and fill orders promptly.

Our Salesmen

whose traveling expenses we pay with pleasure,
because they always talk to the point,
are
Sample Packages of Six Files,
and our Price List with Discounts.

Your permission to send you one of these quiet, modest,
unpretentious but efficient Salesmen
will much oblige,

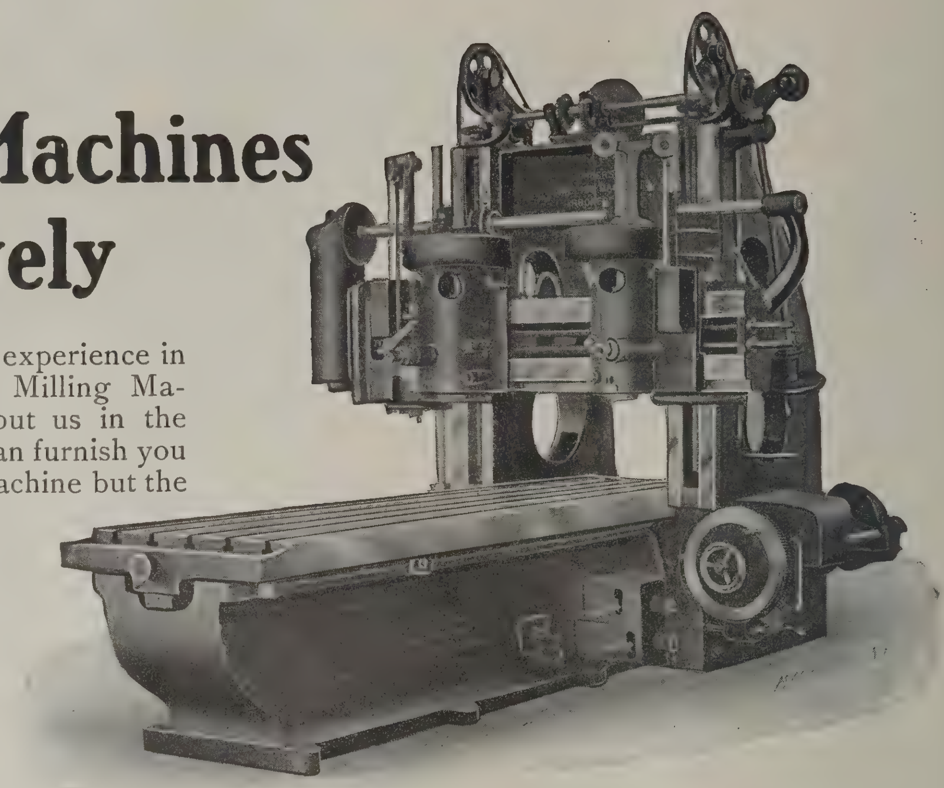
E. P. Reichhelm & Co.

Principal Owners and Selling Agents of the American Swiss File and Tool Co.

24 John Street, N. Y. City

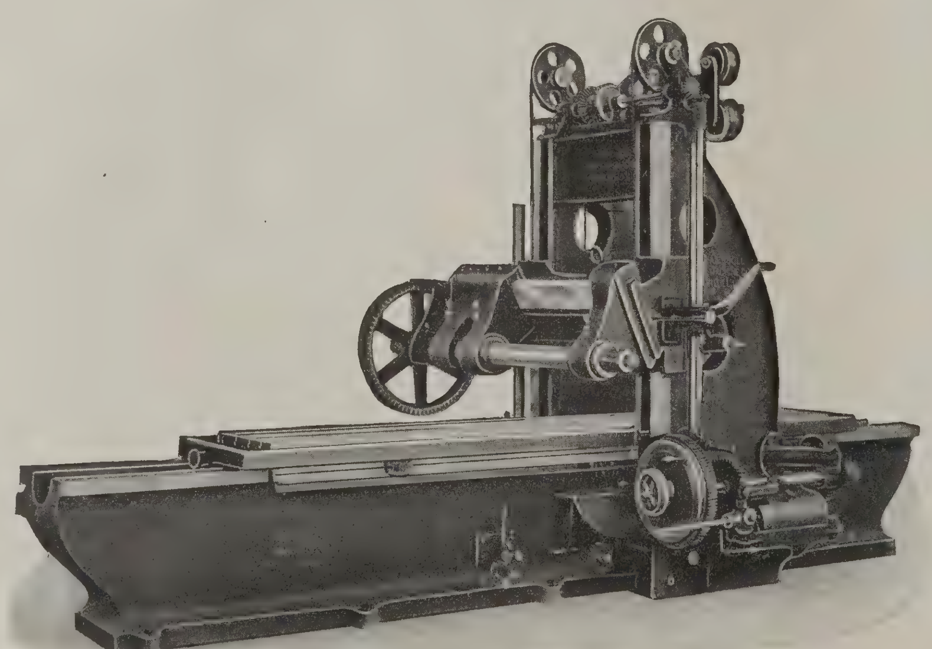
Heavy Milling Machines Exclusively

"Our twenty years' experience in building Heavy Type Milling Machines certainly has put us in the front rank, so that we can furnish you not only a first-class machine but the very best. All sizes and types, suitable for the very lightest automobile aluminum gear cases, up to the heaviest kind of work found in any large machine shop."



48-inch Double Vertical Spindle Milling Machine.

One, Two, Three or Four Spindle arranged any way to suit requirements.



This Horizontal Machine with our Vertical Spindle Attachment covers a wide range of work.

Standard Horizontal Type All Sizes

The Ingersoll Milling Machine Company

ROCKFORD, ILLINOIS, U. S. A.

Eastern Branch, 114 Liberty Street, New York, Walter H. Foster, Mgr.

TRADE-MARK.

No. 62,316. REGISTERED APR. 30, 1907.

NEWTON MACHINE TOOL WORKS INCORPORATED.

CERTAIN MACHINERY.

APPLICATION FILED APR. 25, 1906.

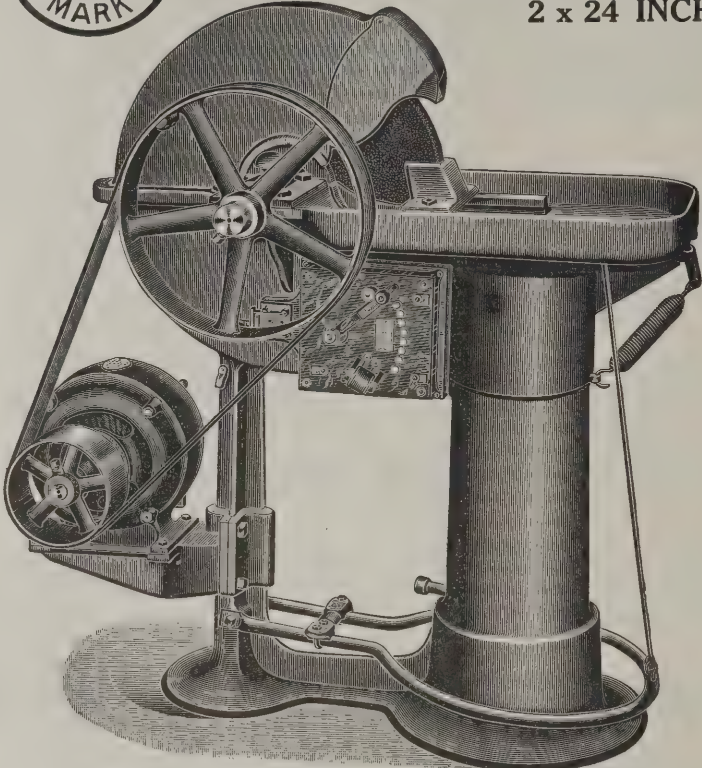
NEWTON

Witnesses:-
Wills A Burrowes
Titus H. Irons

Proprietor-
Newton Machine Tool Works,
Incorporated, by its Attorneys,
Howson & Howson

Water Emery Grinder

2 x 24 INCH WHEEL



NO VALVES
NO PUMPS

Always ready for use

THIS grinder is most efficient in use, simplest in construction, and size of wheel best adapted for tool works; a wheel of less diameter or wider face gives all kinds of trouble; we know by experience and our experience saves the customer money.

Can furnish with

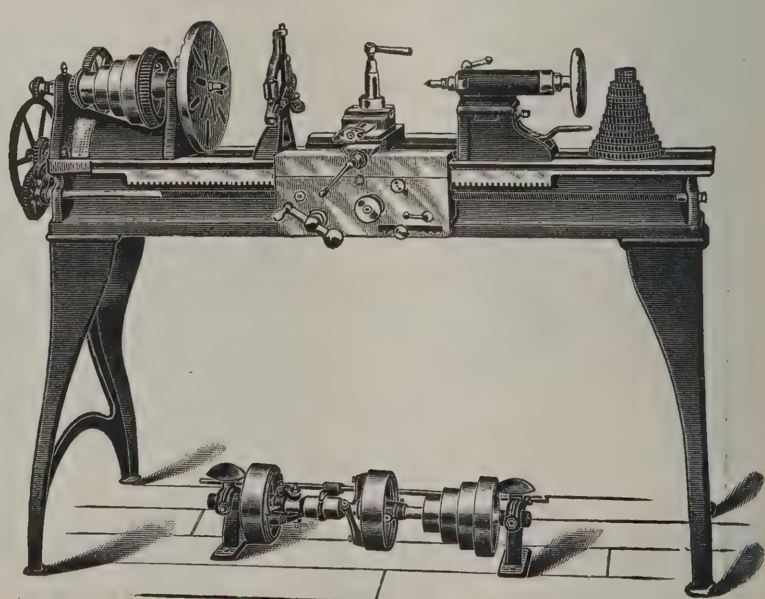
Electric or Countershaft Drive

For electric drive we use a 2-H.P. motor

SEND FOR CATALOGUE

These two tools make a pretty good start for a small machine shop. The drill is our No. 7—15-inch Swing Drill, a stiff tool for its size and well adapted for light medium work; just note the combined lever and wheel feed! The lathe is our No. 13 Lathe, swinging 13 inches over the face plate, and made in beds of 5 to 10 feet long; has automatic cross-feed and compound rest; very stiff tool carriage and changes of feed without removing a gear. We can furnish Lathe with foot power if wanted.

A good deal less than $200 will buy this Drill and the Lathe with 5-foot bed. Write for catalogue.

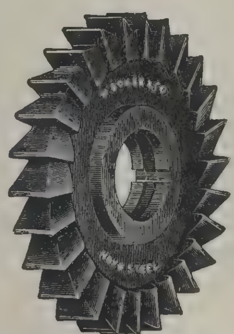


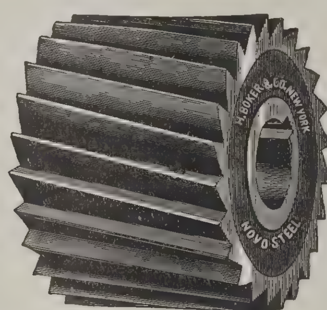
W. F. AND JOHN BARNES COMPANY

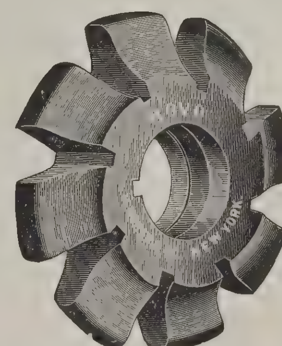
231 Ruby Street — **Established 1872** — **Rockford, Illinois**

"NOVO" MILLING CUTTERS ARE ON TOP

We carry a complete stock of Novo Spiral Milling Cutters, Side Milling Cutters, Nicked Tooth Milling Cutters, Novo Gear Cutters, and Novo End Mills.







Novo High Speed Milling Cutters

DOUBLE YOUR OUTPUT

We absolutely guarantee all our Novo Milling Cutters. A Novo Milling Cutter will outlast at least two dozen of the Carbon Steel Cutters. Novo Milling Cutters will mill the hardest and sandiest steel or iron castings.

Send us a trial order. Write for price list with full particulars.

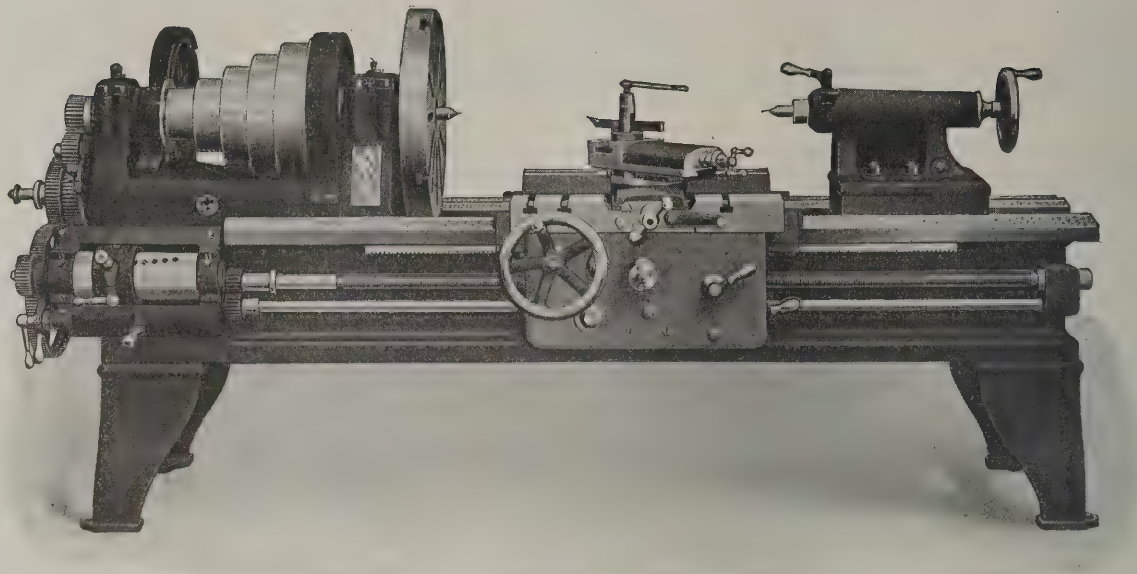
All Novo Milling Cutters furnished subject to trial and approval.

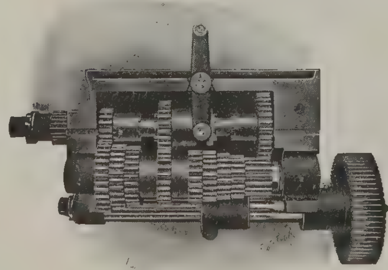
HERMANN BOKER & COMPANY

SMALL TOOL DEPARTMENT

Chicago Warehouse
57 N. Desplaines Street

New York City
101-103 Duane Street



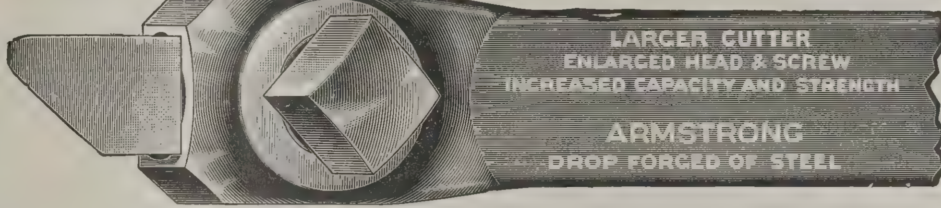


ARMSTRONG TOOL HOLDERS

will do more work and cause less trouble than any other tools you can put on your lathes and planers. Experience counts in making tool holders just as it does in any other line, yours for instance. It's easy for us to make better tool holders than anybody else; that's been our specialty for years, and it don't cost us (or you) one cent extra. **We make a complete line. A Tool Holder for every operation on the lathe and planer.**

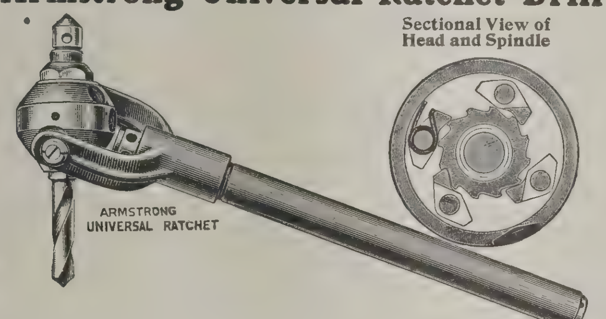
Cutter is Extra Large and is supported directly under strain of cut.

Our Patented Relieved Seat prevents chattering and breaking of cutter.



Patented February 28, 1893, and patent pending.

Armstrong Universal Ratchet Drill



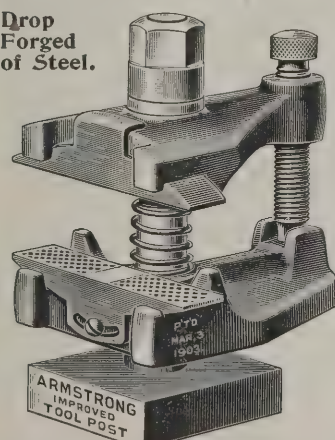
Sectional View of Head and Spindle

Two inches of motion, at end of handle, in *any direction* will drive the drill. No lost motion—cuts faster than common ratchet. Write for special circular.

A Few of these Ratchets

in your erecting or repair department will repay their cost many times in the course of a year. They have a special field of their own in which neither air or electric drills nor the common ratchet can compete.

Drop Forged of Steel.



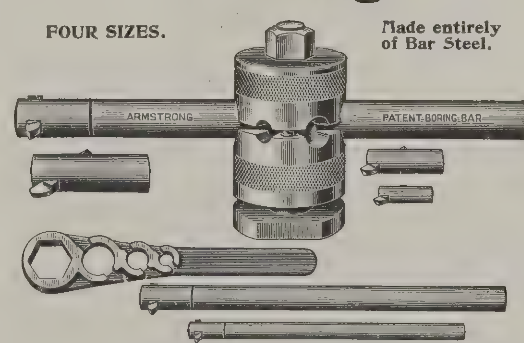
The Armstrong Improved Tool Post

FOUR SIZES

OUR Improved Tool Post combines in itself the strength and holding power of the Strap and Stud Tool Clamp with the convenience of the "open side" and ordinary Set Screw Tool Post. Write for special circular.

3-Bar Boring Tool

FOUR SIZES. Made entirely of Bar Steel.



Increases production and reduces cost of tool maintenance. Cutters cannot jar loose. **High Speeds and Big Feeds** only set them tighter. Write for special circular.

Do you want our new catalog? It's A Tool Holder Encyclopedia.

Armstrong Bros. Tool Co.,

"The Tool Holder People" 113 N. Francisco Avenue, CHICAGO, U. S. A.

Imitations are Unsatisfactory ::: Infringements are Unlawful.

Thirty-two Changes of Feed

Without Shifting a Belt or a Gear. Does this feature of the

"OWEN"

No. 2-A Universal Miller

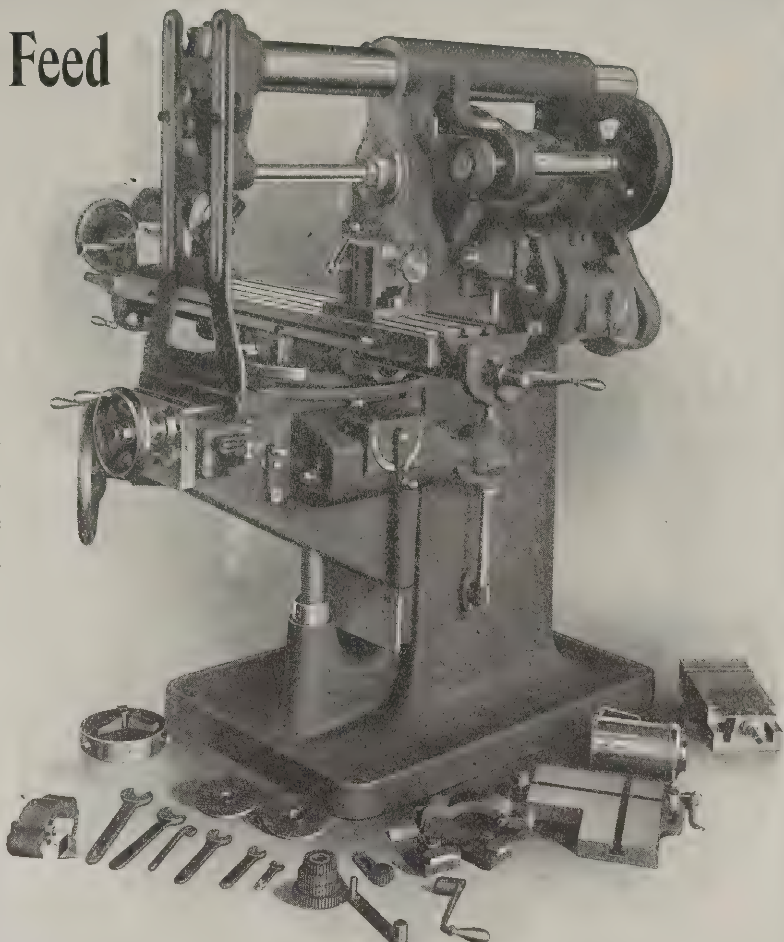
Strike you favorably? There are other points that will make an equally good impression if you will inquire into them. "OWEN" Milling Machines are the modern millers; built for high speed work; accurate, rigid, powerful. Gear drive, double bearing surfaces to table, column extra heavy at front spindle bearing.

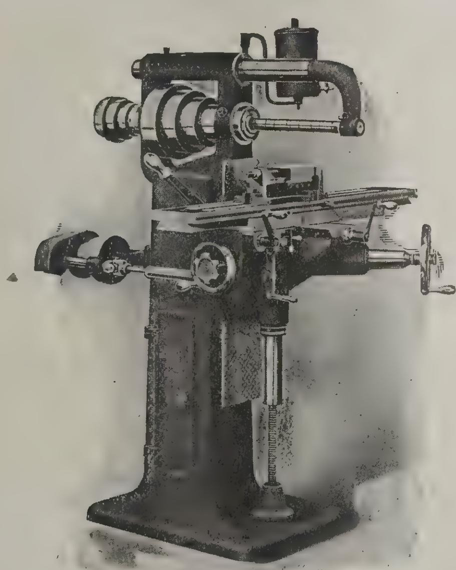
Special Circular mailed on request

THE OWEN MACHINE TOOL CO.

Springfield, Ohio, U. S. A.

FOREIGN AGENTS—Alfred Herbert, Ltd., Coventry, England. DeFries & Co., Akt. Ges., Dusseldorf, Berlin and Stuttgart, Germany; Milan, Italy; Barcelona, Spain. Louis Besse, Paris, France. Wilh. Sonesson & Co., Malmo, Sweden.





FOX MILLERS

We make a specialty of Milling Machines for light work which are particularly designed for such service as requires extreme accuracy to be coupled with low cost of production. For the manufacture of instruments of all kinds, sewing machines, small firearms, typewriters, talking machines, telephone and telegraph instruments and all classes of light electrical work, the machines are ideal.

Illustrated catalog free.

Fox Machine Co. 815 N. Front Street Grand Rapids, Mich.

No **Tool Room** is complete without a

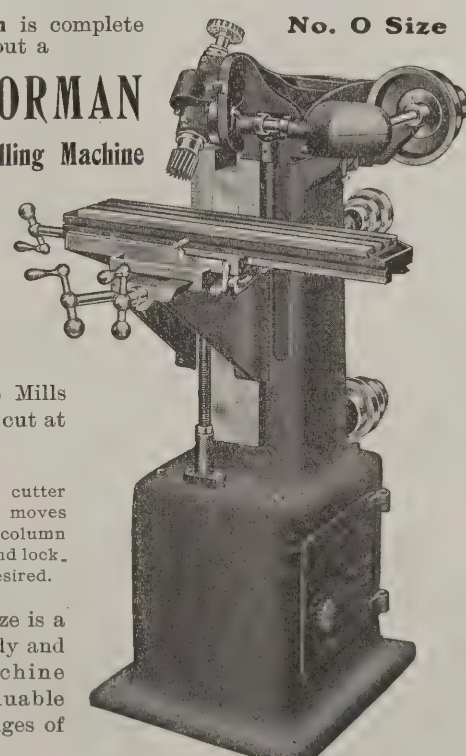
No. O Size

VAN NORMAN

"DUPLEX" Milling Machine

IT

saves **Time**
saves **Money**
saves **Cutters**
saves **Fixtures**



Right Angle Mills can be used to cut at all angles.

Ram on which cutter head is mounted moves in and out over column and may be set and locked at any point desired.

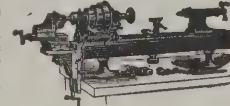
The No. 0 size is a powerful, handy and accurate machine especially valuable for quick changes of operation.

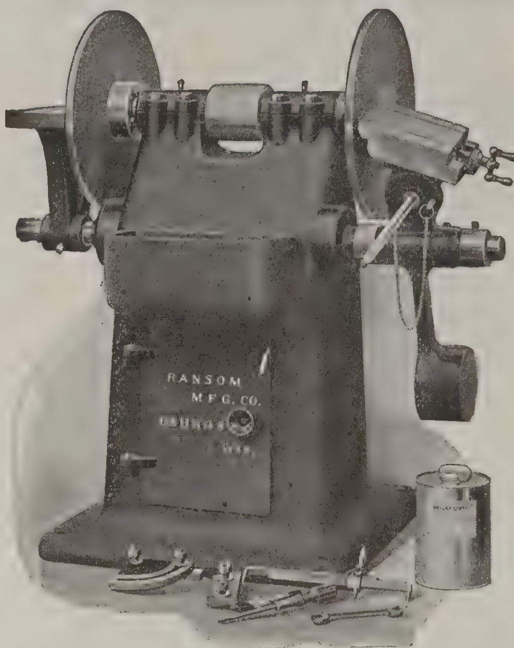
Waltham Watch Tool Company

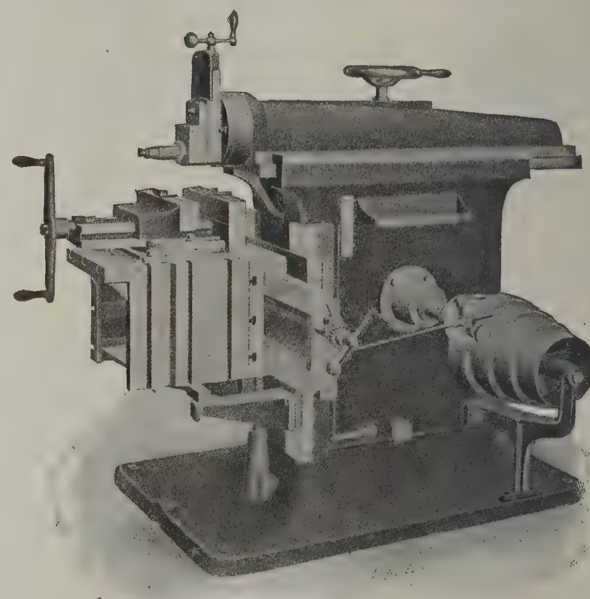
Springfield, Mass., U. S. A.

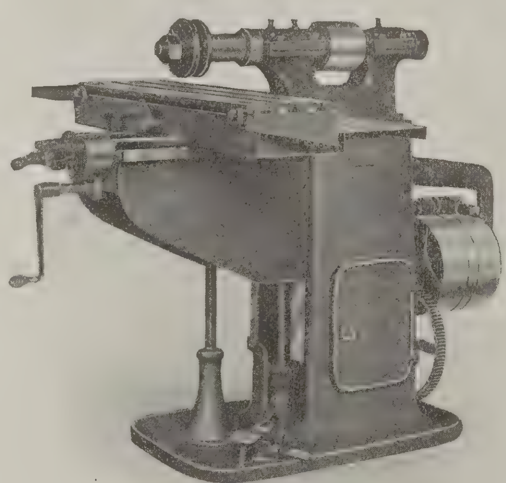
No. 5 Bench Lathe

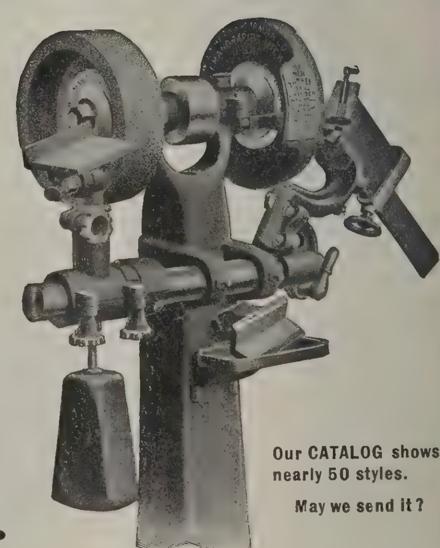
The Van Norman No. 5 Bench Lathe split chucks will also fit the Van Norman "Duplex" Millers—a good combination.



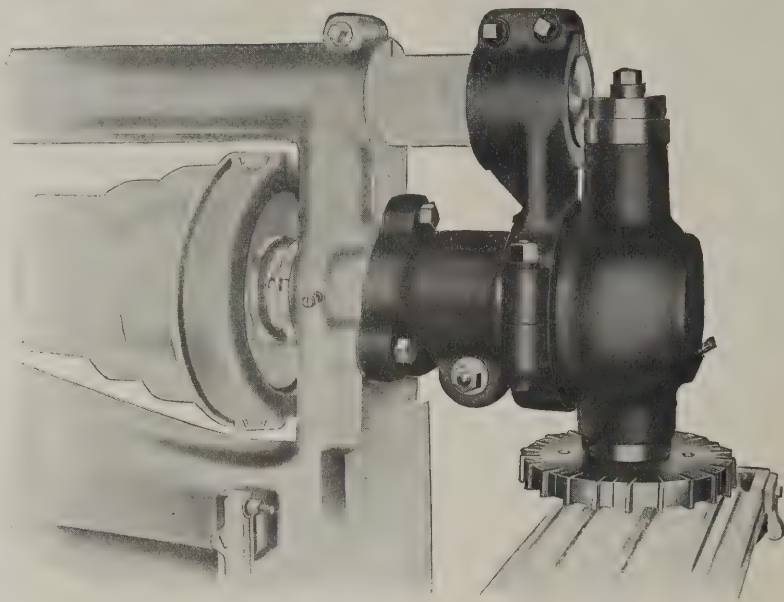

RANSOM
MFG. CO.



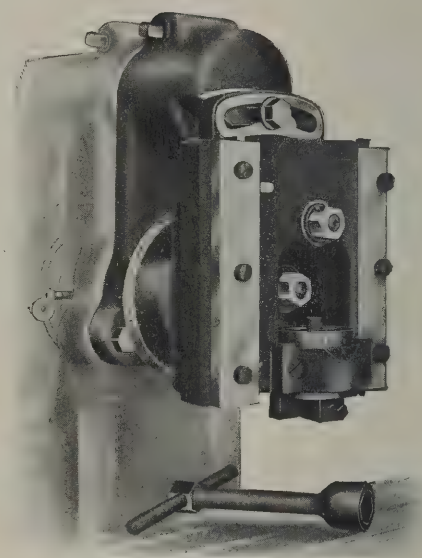




KEMPSMITH MILLING MACHINE ATTACHMENTS



EXTRA HEAVY VERTICAL MILLING ATTACHMENT



SLOTTING ATTACHMENT

The attachments are capable of the full pulling power of the main spindle of the miller. These are only samples of the character of attachments we are able to furnish with our milling machines.

THE KEMPSMITH MFG. CO., Milwaukee, Wis.

European Agents: Selig, Sonnenthal & Co., London, E. C. Canadian Agents: London Machine Tool Co., Ltd., Hamilton, Ont.
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POWERFUL--RIGID--ACCURATE

MACHINE TOOLS
for
HEAVY DUTY

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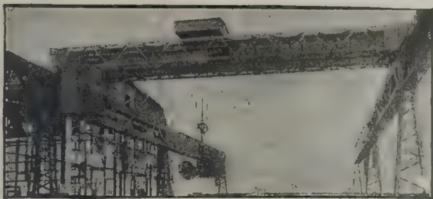

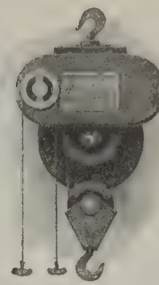

ELECTRIC HOISTS

Get Prices

Northern Engineering Works, 26 Chene St., Detroit, Mich.

New York: 120 Liberty Street Philadelphia: Land Title Building Chicago: 405 Monadnock Block

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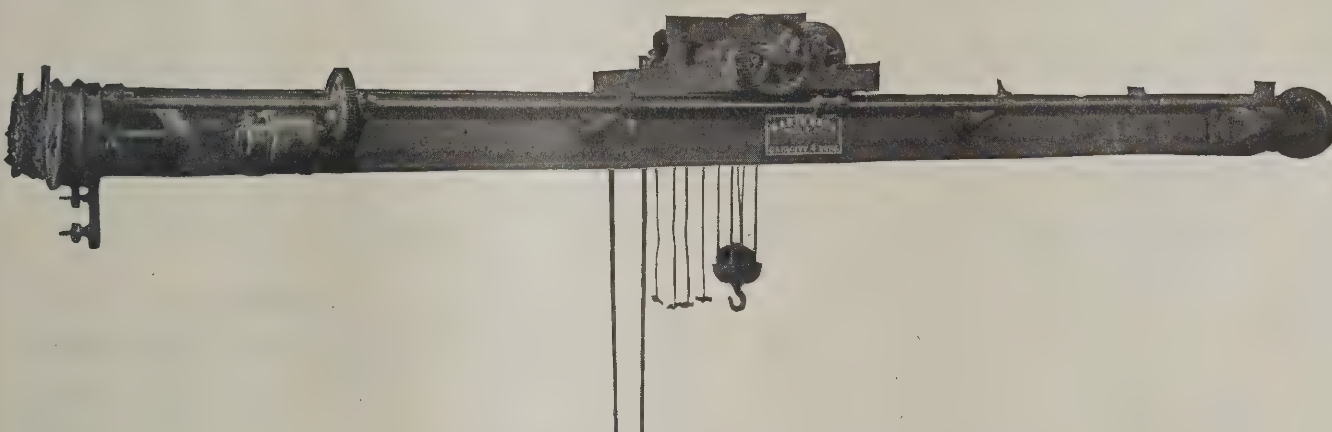
CRANES ELECTRIC & HAND

OPERATED FROM THE FLOOR



3 tons, 2 motors. Hoist and Bridge motion by power. Trolley motion by hand chain.

A handy crane for erecting floors in machine shops and for all service where loads are to be handled quickly and at low cost. Made with one, two or three motors, for power hoist, power hoist and bridge travel, or power hoist, bridge and trolley travel.

MARIS BROS.

56th St. and Gray's Ave., PHILADELPHIA, PA.

Manning, Maxwell & Moore, Inc., Agents, New York—Pittsburg—Chicago—Boston—Cleveland.

TRAVELING

CRANES AND HOISTS

1-4 Ton to 200 Tons Capacity

2000 MACHINES IN USE.

Repeated orders from extensive users prove our claims for superior design, workmanship and completeness in all details. We manufacture and assemble every part and test the complete machine before shipment.

PAWLING & HARNISCHFEGER, - Milwaukee, Wis.

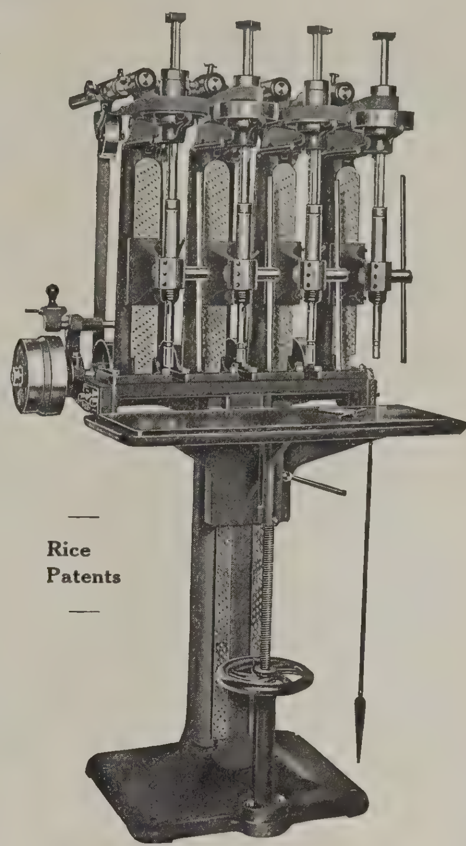
THE TOOL THAT WILL REDUCE
YOUR DRILLING COSTS

The Henry & Wright Ball Bearing Drill

The most popular drilling machines on the market because they "make good" on all essential points. Stronger and heavier than other machines of like capacity. Require less power for operation. Ball bearing construction eliminates friction and makes them practically indestructible. The belt system is so simple and oiling so infrequently needed that the minimum attention on these points is required. They are built on the interchangeable plan, are especially adapted for high speed steels, and will drill from 200 to 400 per cent. more holes in a given time than any other drill using the same amount of power.

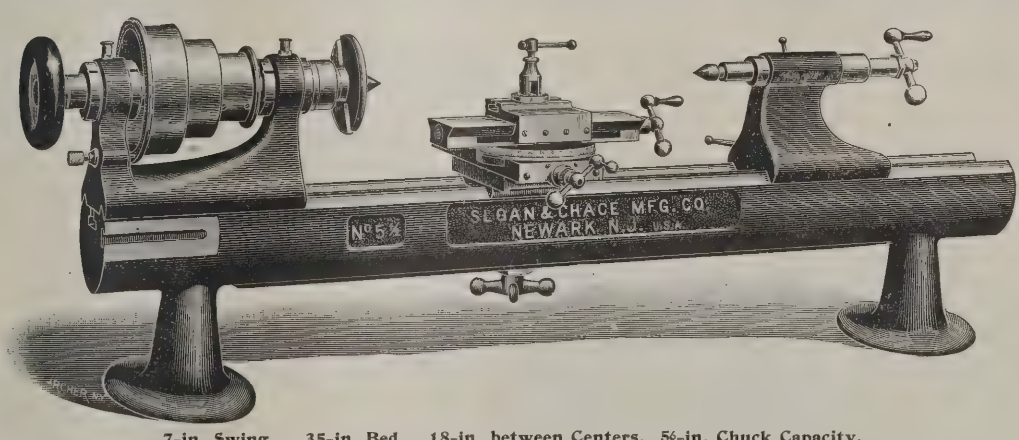
DRILL BOOK FOR THE ASKING

The Henry & Wright Mfg. Co.
HARTFORD, CONN., U. S. A.



Rice Patents

No. 5½ Sloan & Chace Bench Lathe

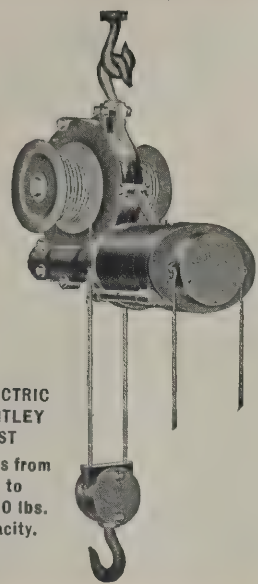


7-in. Swing. 35-in. Bed. 18-in. between Centers. ⅝-in. Chuck Capacity.

A new size in our line of Precision Lathes, with improved form of bed, adding to its strength and rigidity, off-set tail stock, and increased capacity of split collet. These machines insure the acme of accuracy, yet are strongly built and will stand severe service. They are designed with every convenience for rapid handling, and save time and labor in the general everyday work as well as in special high grade manufacturing. *Write for Bulletin. We build a complete line of Precision Tools.*

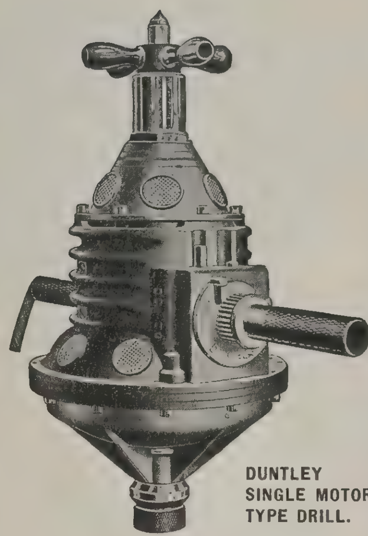
Sloan & Chace Mfg. Company, Ltd.
NEWARK, N. J., U. S. A.

IT'S THE DISCRIMINATING MAN



ELECTRIC DUNTLEY HOIST
Sizes from 250 to 2000 lbs. capacity.

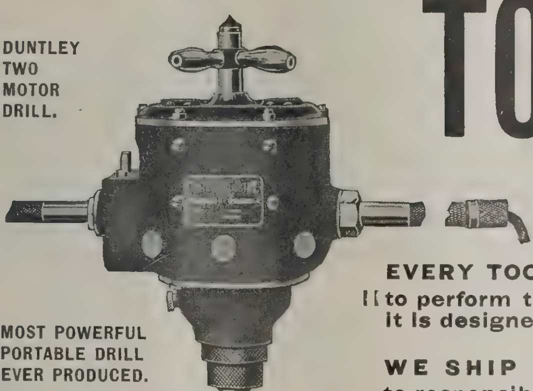
The man who thoroughly and carefully inspects every detail of tool construction from outer casing to innermost working part



DUNTLEY SINGLE MOTOR TYPE DRILL.

WHO ALWAYS BUYS

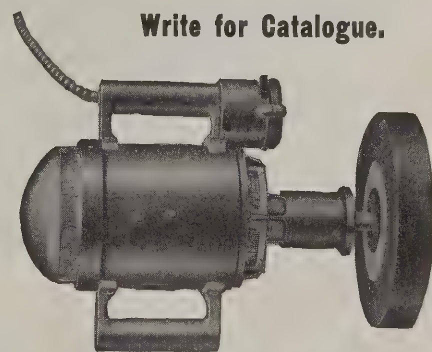
DUNTLEY AIR COOLED PORTABLE ELECTRIC TOOLS



DUNTLEY TWO MOTOR DRILL.

MOST POWERFUL PORTABLE DRILL EVER PRODUCED.

Write for Catalogue.



DUNTLEY ELECTRIC GRINDER
Built in Two Sizes.

WE MAKE THEM IN ALL SIZES

EVERY TOOL IS GUARANTEED to perform the service for which it is designed.

WE SHIP THEM ON TRIAL to responsible parties any where.

WOUND FOR ALTERNATING OR DIRECT CURRENT.

FRANKLIN AIR COMPRESSORS

Are being built and installed at the rate of

60 PER MONTH

STEAM DRIVEN FRANKLIN AIR COMPRESSOR.

We build them in more than

100

STYLES AND SIZES

CHICAGO PNEUMATIC TOOL COMPANY

Fisher Building
CHICAGO

95 Liberty Street
NEW YORK

We manufacture "Boyer" and "Keller" Riveting, Chipping and Calking Hammers, "Little Giant" Air Drills and a complete line of pneumatic tools and appliances.

ROUND HOLES AT A MINIMUM COST

One of the difficulties that confront the automobile and gas engine manufacturer is how to obtain a round, straight, smooth bore in the cylinder at a reasonable cost.

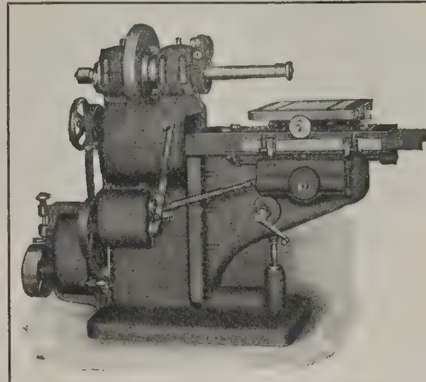
THE HEALD CYLINDER GRINDER

Solves the problem on every point—is especially designed to do accurate internal grinding in a special way, and has unusual features that permit rapid handling, overcome the every-day difficulties of such work and reduce the cost to the lowest limit.

It is also a valuable tool for the machine tool builder, as the work not being revolved, holes can be finished in castings of any shape.

We shall be glad to forward our Treatise on Internal Grinding if you are interested.

THE HEALD MACHINE COMPANY
147 BOND STREET WORCESTER, MASS.



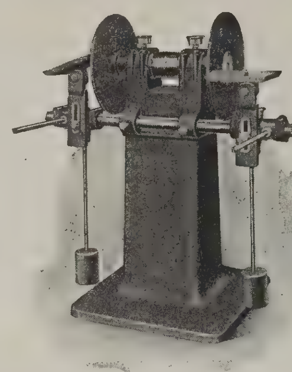
VITRIFIED CORUNDUM WHEELS

THE COOLEST CUTTING WHEELS

on the market and the most satisfactory on every other count. Made from almost pure corundum, by the vitrified process, they are 50 per cent. more efficient than other abrasive wheels, cut faster and cleaner, will not glaze and never draw the temper of the tool being ground.

Sent on trial when desired.

The Vitrified Wheel Company
WESTFIELD, MASS.



STOP, LOOK, LISTEN—

"OUR GUARANTEE"

The Ney Disk Grinder is the equal of any made, in Cutting Speed. We do not "guarantee" this only, but we *state* it and it's *a fact.*

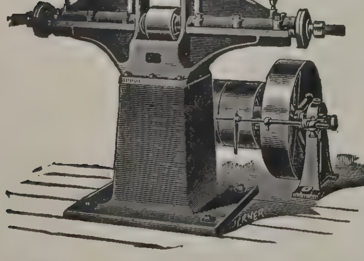
The *ordinary* loose guarantee simply means that if a machine doesn't fulfill the maker's claims you can return it—and try someone else. Now, where do you come in on that?

"OUR" guarantee means that if our machines are not as represented we will send you one that *is* right. Our first complaint is yet to arrive.

PRECISION DISK GRINDERS

ROSCOE W. NEY, Kingston, N.Y.

Emery Wheels and Grinding Machinery



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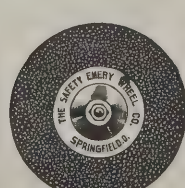

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Pfeil & Co., London.
F. Lowener, Copenhagen, Stockholm.
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THE SAFETY EMERY WHEEL COMPANY, Springfield, Ohio, U. S. A.

Standard Engine Lathes

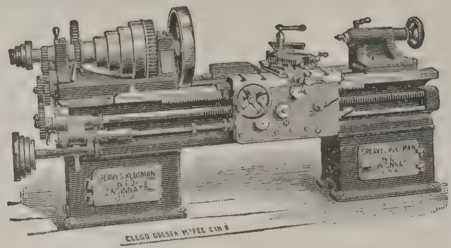
16 to 24 inch Swing

Built by

Greaves, Klusman & Co.

S. E. Cor. Cook & Alfred Sts.

CINCINNATI, OHIO, U. S. A.



Also Builders of Pattern Makers' Lathes and Machinery and Metal Spinners' Lathes

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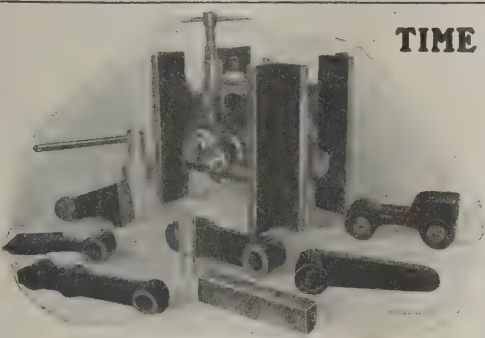
The Baker Improved Turret Head

Saves Dollars and Makes Dollars—Applicable to any speed or engine lathe.

This device gives all the advantages of a turret lathe. Holds the regular turret head tools and handles turret lathe work as quickly, accurately and profitably as a full-fledged turret machine. Two sizes. Write us.

The Baker Machine Corporation

New Bedford, Mass.



Fortin Jig and Samples of Work

TIME SAVED—MONEY SAVED

The bother and vexation of getting up special jigs can be avoided by using the

Fortin Universal Jig

Patent applied for)

This thoroughly practical device is easily adjusted, works accurately and covers all ordinary work within its range. Let us send you particulars. Made in 10 sizes.

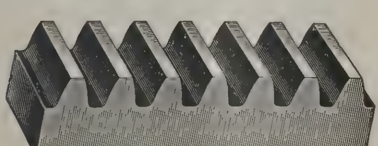
THE B. P. FORTIN TOOL CO.

WOONSOCKET, R. I.

PATTERNS

of Every Description.

Penn Pattern Works, Chester, Pa.



DELAY IS SUCH

A BUSY RASCAL

ACCURACY

FINISH

PRICE

Are our

CARDINAL POINTS

ELIMINATE CHANCE INTRODUCE SCIENCE

WRITE US TODAY ABOUT

YOUR RACK

It will cost you real money

To turn this down

Standard Gauge Steel Co., Beaver Falls, Pa., U.S.A.

Pacific Tool & Supply Co., San Francisco, Cal. Seattle Hardware Co., Seattle, Wash.
Hall & Pickles, 64 Port St., Manchester, England.

The Government Machine Shops are using

LANG'S "T" BOLT HEADS

Drop Forged Steel

and it's a good tool that can run the gauntlet of Uncle Sam's inspection.

For the boring mill, planer, milling machine or other tool where work is clamped to the table, these "T" Bolt Heads save incalculable time and trouble. No need to clean out the slot before putting on a new job. Lang's "T" Heads can be set where needed after the work is in position. They are used with studs instead of bolts so a good supply can always be kept on hand, they have a smooth bearing against the T slots, are strong, will not slip or bend and work so clamped is firm and stiff.

A dozen Lang's "T" Heads will take the place of a hundred bolts and do more work.

May we send our circular?

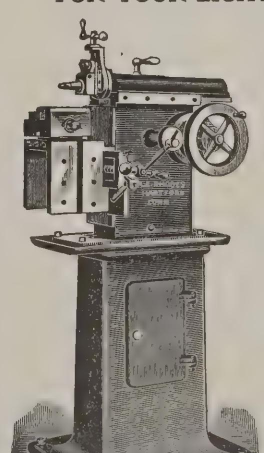
G. R. LANG CO.

MEADVILLE, PA.

Bailey-Smith Mchy. Co., San Francisco.
C. W. Burton, Griffiths & Co., London, England.

A LITTLE SHAPER

FOR YOUR LIGHTER WORK



All the essential features of the high priced machines are incorporated in the

RHODES

7 in. Crank Shaper,

and it will take care of small tool, die, model and light shaper work in general, quickly and accurately. Micrometer adjustment on both screws; quick adjusting vise.

Can be used as a bench machine when desired.

Circulars on request.

L. E. Rhodes

Hartford, Conn.

SPECIAL MACHINERY

And Machines Built on Contract.

Jigs and Fixtures, Punches, Dies, general machine work. Fifteen years experience on work of this character. Send blue prints and let me estimate on your work—it's money saved.

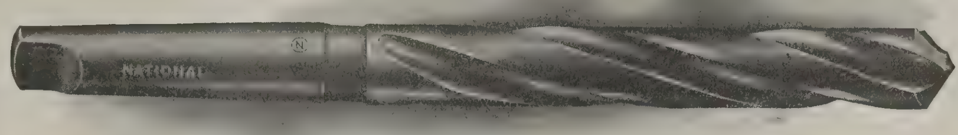
CHAS. S. DEXTER

30 Railroad St., Attleboro, Mass.

Professional.

High Speed Twist Drills and Tools

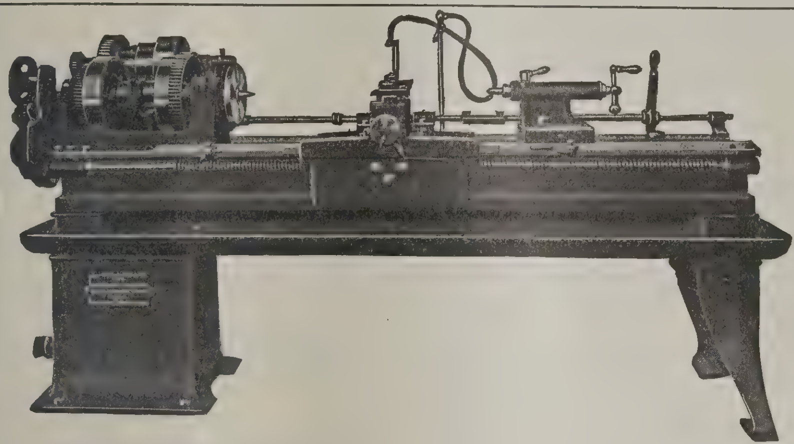
Special three and four fluted **High Speed Drills** for reaming and drilling cored and punched holes.



We make a Specialty of **HIGH SPEED TOOLS**

Manufactured by **THE NATIONAL TWIST DRILL & TOOL CO., DETROIT, MICH.**

General Sales Agents: **Whitaker Mfg. Co., Chicago, Ill.**



THREADED WORK

of all kinds, internal or external—screws, worms, nuts—right or left hand threads, straight or taper, can be accomplished with the

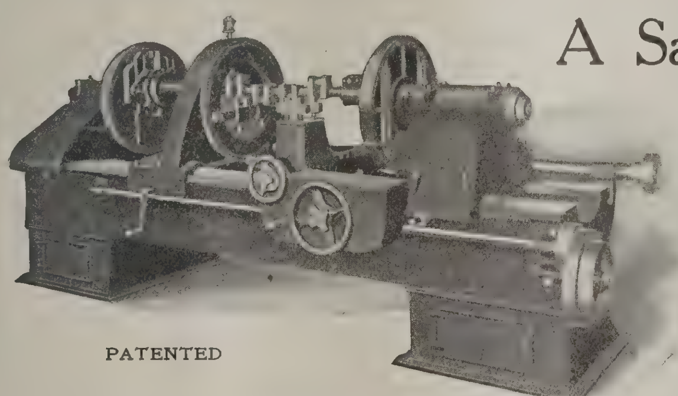
AUTOMATIC THREADING LATHE

more rapidly, with greater ease and with greater economy than by any other method. Does not require special tools. Entirely automatic in operation, so one man can look after several machines.

Let us send you catalogue and examples of rapid thread cutting.

AUTOMATIC MACHINE COMPANY, - - - - BRIDGEPORT, CONN.

AGENTS: C. W. Burton, Griffiths & Co., London; A. H. Schutte; Schuchardt & Schutte; Marshall & Huschardt Mchy. Co., Chicago; Motch & Merryweather Mchy. Co., Cleveland.



PATENTED

A Saving of 1/3 to 1/2 in Time on Crank Shaft Turning

is assured with the Tindel-Albrecht Crank Shaft Lathe. This is a heavy, rigid machine with particularly powerful drive and special features that put it ahead of any other machine for rapidly reducing rough crank shaft forgings to grinding sizes.

Uniform drive from end to end. Write us about it.

THE TINDEL-MORRIS COMPANY, EDDYSTONE, PA., U. S. A.

EUROPEAN REPRESENTATIVES—De Fries & Cie., Dusseldorf, Germany. De Fries e. C., Via Principe Umberto. Angola Via Moscova, Milan, Italy. De Fries y Cia., Cortes 660, Barcelona, Spain. De Fries & Cie , 19 rue de Rocroy, Paris, France. De Fries & Cie , 36 Rue Fosse aux Loups, Brussels. Be gium.
Distributors for North America, South America and Japan, Niles-Bement-Pond Co., 111 Broadway New York.

"CHAMPION"

14-inch Engine Lathe

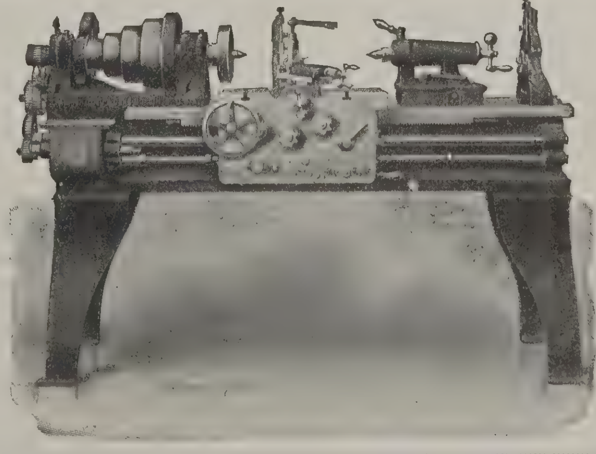
An up-to-date machine, new design, extra large ground spindle, wide face gearing, T-slots in carriage, rapid feed changes, wide belt. It is provided with an Index Dial for catching threads quickly, has automatic stop in either direction, and cuts threads from 2 to 96.

For other special features see our circular.

Champion Tool Works Co.

2422 Spring Grove Ave. CINCINNATI, O., U. S. A.

10, 12 and 14-inch Lathes



It Is Shop Economy

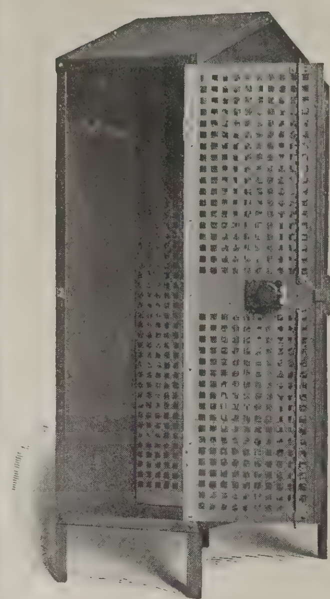
to have a **Cut-Meter** for every machine tool With this device at hand there is no excuse for speeds below the standard. It is simple, requires no timing or calculation; adaptable, can be used on any machine; convenient, can be held in any position—and shows the operator instantly and exactly, the cutting speed in feet per minute at which his machine is running.

Built for hard service and will save its cost a hundred times over in a year.

Send for catalogue.

Warner Instrument Company
56-59 Roosevelt Avenue
BELOIT, WIS.
1691 Broadway, New York. 153 Federal St, Boston

You'll Find Hart & Cooley Lockers

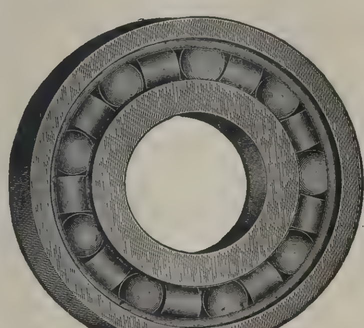


in shops and factories where modern methods prevail, because the H. & C. Locker is essentially up-to-date. They are built on the unit system, adaptable to any space; material is wrought steel perforated stock—smooth, finely finished, easily cleaned. Hooks, shelves, locking devices are of the most approved order. Full line of sizes. There are other good-locker points made plain in our Catalogue "C"—may we send a copy?

The Hart & Cooley Company
New Britain, Conn.

Radial Ring Bearings

"NOISELESS"

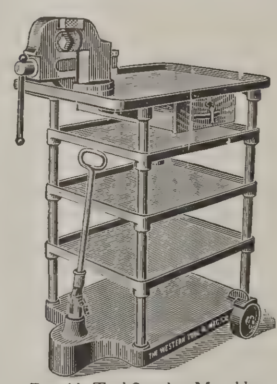


Bantam Anti-Friction Co.
Bantam, Conn.

Finished Machine Keys

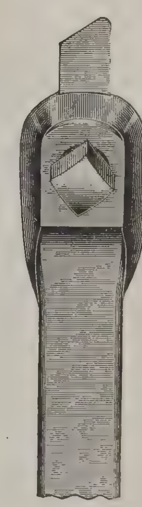
Cheaper than you can make them. Finished "Ready to Drive."

Gib and Plain Head
All sizes carried in stock.
Write for discounts.
OLNEY & WARRIN
66-68 Center St., New York



Portable Tool Stand or Movable Bench.

Tool Holders
Expanding Mandrels
Portable Stands
Adjustable Reamers
Steel--High Speed
and Self-Hardening
Surfacing Tools, Etc., Etc.



New catalogue just out—free.

The Western Tool and Mfg. Co.

SPRINGFIELD, OHIO, U. S. A.

Our Combined Separator and Filter

IS A PRACTICAL OIL SAVER.
Does not require skilled attendant.
Sent on 30 days' trial if desired.

National Separator and Machine Co.
CONCORD, N. H.

STEEL BRASS **BALLS**
"KNIPE" PAT. **BALL BEARINGS**

¼ in. Shaft and up. No fitting, just push them on. 10 cts in stamps for sample.

PRESSED STEEL MFG. CO.
454 The Bourse, Philadelphia, Pa.

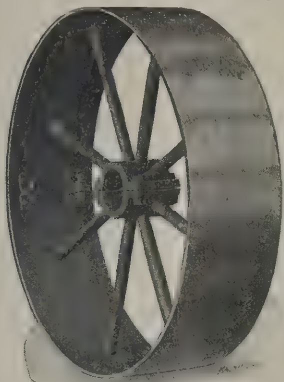
POLISHING BELTS

MACHINERY AND SUPPLIES

L. H. GILMER COMPANY, - Philadelphia

The "Latshaw" All Steel Split Pulley.

Built to do the work of a double belt cast iron pulley and without the use of key-seat or set screws. The easiest pulley to put on. True running at all speeds.



They are simple in design. Similar to cast iron in appearance, made without **Rivets** at arm fastenings in hub and rim.

"Last but not least, prices are satisfactory."

Eightarm construction, used on pulleys from 30″ to 50″ inclusive, 4″ to 12″ width of face inclusive.

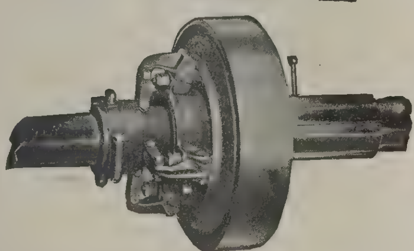
Ask your dealer.

Latshaw Pressed Steel & Pulley Co.,
Pittsburgh, Pa.

Boston Stock: Brown, Wales & Co. Chicago Stock: R. R. Street & Co. New York Stock: Henry J. McCoy Co.

THE SCHWERDTLE STAMP CO.,
STENCILS—BURNING BRANDS
STEEL STAMPS & DIES
SEALS—MACH. PLATES—CHECKS
BRIDGEPORT, CONN.

The
UNIVERSAL GIANT



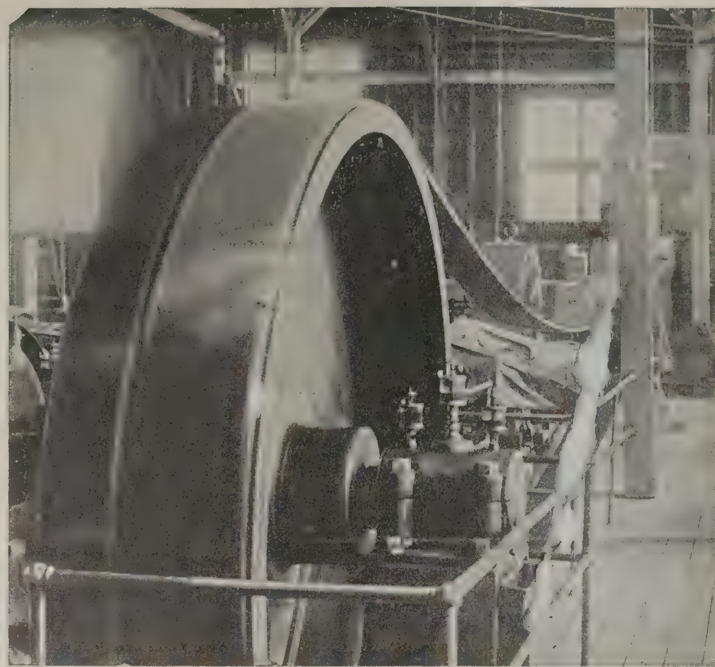
Friction Clutch

No Special Pulleys are needed with this Clutch, any ordinary pulley, solid or split can be used, saving expense and bother. It is strong, compact, easily adjusted, will run at any speed and is the Clutch for modern conditions.

For sale by all dealers or direct

T. B. Wood's Sons Company
Chambersburg, Pa.

Mfrs. of Shafting, Pulleys, Hangers, Couplings, etc.



Old or Oily Belts

Don't throw these away.

Treat them with Cling-Surface and make them new again.

This belt was old, full of oil and dirt (we took 30 lbs. off it) when put on.

It was very tight and wouldn't half work.

We scraped it, treated and slacked it up and it was doing 140 H.P. when photographed and doing it easily.

The oil was coming through the back in drops—pushed out by the Cling-Surface.

You can take any belt you have, new or old, dry or oily, use Cling-Surface and run it slack, no matter what its position, and pull fullest loads.

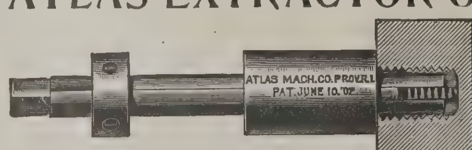
We guarantee it. Try Cling-Surface and see.

Write us. We have a mighty interesting matter for you.

CLING-SURFACE CO 1018 Niagara St Buffalo N Y

New York Chicago Boston Philadelphia St Louis London Thomas & Bishop 119-125 Finsbury Pavement E C

ATLAS EXTRACTOR OF BROKEN TAPS



A strong and simple device for removing taps broken off in a tapped hole. Saves its cost in the time saved removing the first broken tap.

Send for catalogue and price list.

ATLAS MACHINE COMPANY, - PROVIDENCE, R. I.
Also Makers of the Atlas Swivel Vise and Atlas Tool Makers' Vise.

The
AMERICAN
WROUGHT STEEL
SPLIT PULLEY

For all around service.
All dealers carry these pulleys.

Patented in the United States and Foreign Countries.

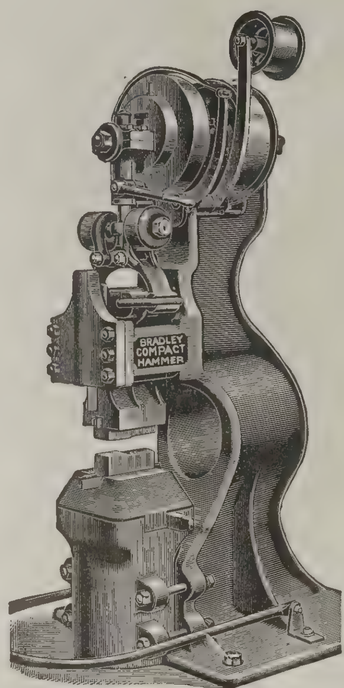
Lighter in Weight and Stronger than other Pulleys.

Save power and are safe under the highest speeds.

Booklet sent on request.

The American Pulley Co.
29th and Bristol Sts., PHILADELPHIA, PA.

Bradley Compact Hammer.



If your forging is of a general, all around jobbing character with frequent variations in the size of stock, or

If it is of such a nature that the hammer is not working continuously, but with frequent stops, or

If your floor space is limited but with good height, a Bradley Compact Hammer would prove a money maker.

It is compact in design, occupies but little space and can be run at high speed.

As it weighs considerably less than our regular Upright Hammer its price is much less.

Made with head weighing 15 to 200 pounds.

WE MAKE....

- **The Bradley Cushioned Helve Hammer.**
- **The Bradley Upright Strap Hammer.**
- **The Bradley Upright Helve Hammer.**
- **The Bradley Compact Hammer.**
- **Forges for Hard Coal or Coke.**

SEND FOR CIRCULARS

C. C. Bradley & Son, Syracuse, N. Y.

FOREIGN AGENTS: Schuchardt & Schütte, Berlin, Vienna, Stockholm, St. Petersburg. Alfred H. Schütte, Cologne, Brussels, Liège, Paris, Milan, Bilbao. Buck & Hickman, Whitechapel Road, London.

Scranton

Power Hammers

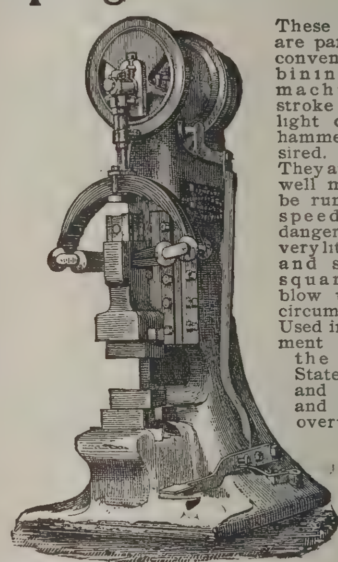
COST LESS than any other hammer that will produce an EQUAL AMOUNT OF WORK.

By our construction we avoid breakdowns.

Send for Circular 37.

The Scranton & Co.
New Haven, Conn.

Spring Power Hammers

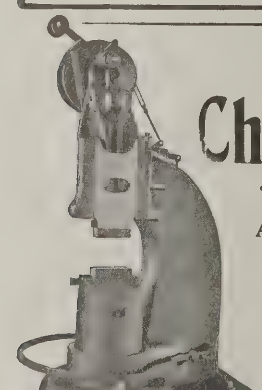


These hammers are particularly convenient combining in one machine the stroke of a very light or heavy hammer as desired.

They are strong, well made, can be run at high speed without danger, require very little power and strike a square, true blow under all circumstances.

Used in government shops by the United States, France and Russia, and sold all over the world.

DIENELT & EISENHARDT, Inc.
1304 No. Howard Street
PHILADELPHIA, PA., U. S. A.



THE BEAUDRY

Champion Power Hammer

Simple, Durable, Efficient and Economical.

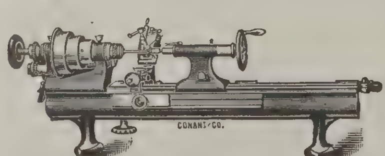
Adapted for Every Description of Forging.

Should be in Every Blacksmith Shop.

Send for Circular.

BEAUDRY & CO., Inc.
141 Milk Street BOSTON, MASS.

Engineers, Electricians, Tool-Makers, Model-Makers



and workers in other lines where extreme accuracy is essential will find that

Stark Precision Lathes

meet their requirements exactly.

Let us send you catalogue B.

STARK TOOL COMPANY, Waltham, Mass., U. S. A.

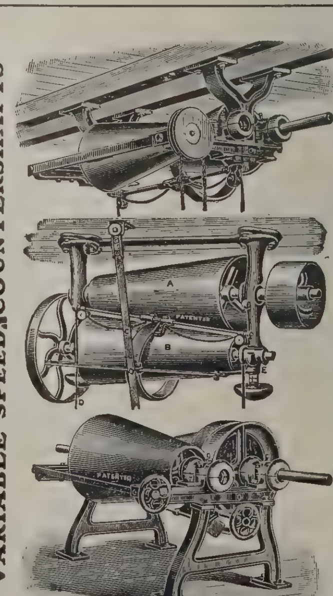
ELECTROTYPERS

All kinds of plates for printing

THE LOVEJOY CO., Established 1853, **444-446 Pearl St., New York**

Evans Friction Cone Pulleys

VARIABLE SPEED COUNTERSHAFTS



Will drive your machine at any desired speed from 1 to 6. Over ten thousand sets in operation in this country and Europe. Send for catalogue.

G. F. Evans, Newton Center, Mass.

Steam Hammers

In all sizes and for every requirement.

Single Frame & Double Frame

Most complete and extensive equipment for their manufacture.

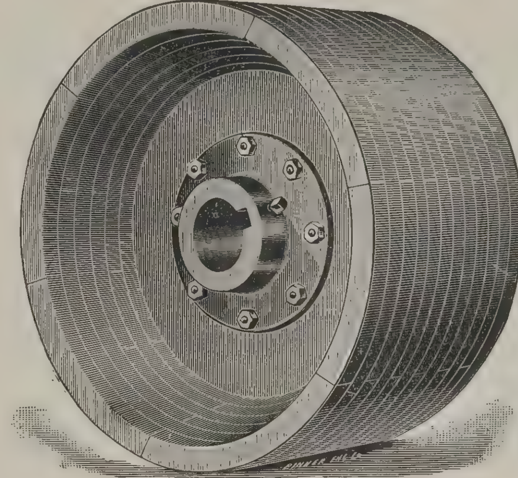
Largest and most modern line of patterns.

Also STEAM DROP HAMMERS
in all sizes up to 12000 lbs.
Falling weight.

CHAMBERSBURG ENGINEERING CO.
Chambersburg, Pa., U.S.A.

For Dynamos, Trip Hammers or other Heavy Work.

We manufacture a solid web pulley especially adapted for extremely severe service and guarantee that it will do the work specified, no matter how heavy. Style D. built of selected, thoroughly seasoned maple, having an iron center fitted with key seat and set screw, is the lightest, strongest, stiffest and best finished Dynamo Pulley on the market.



STYLE D. SPECIAL PULLEY.

The Gilbert Wood Split Pulleys are universally acknowledged to be as perfect, both in material and construction, as it is possible to make them, and can be used successfully wherever a leather belt can be operated. Excel all others in correctness of balance and trueness of running.

Write for illustrated catalogue and price list.

Saginaw Manufacturing Co.

Saginaw, W. S. Michigan.

SALES AGENCIES IN ALL THE PRINCIPAL CITIES IN THE WORLD.

New York Branch, 88 Warren Street. Chicago Branch, 28-32 South Canal Street.
Cable Address, Engrave. A. B. C. and Lieber's Codes.

We Don't Boast

When we assert that **Leviathan Belting** will show up better than any other belt under any condition.

Twenty-five years of manufacturing this scientifically constructed belt, has proved so conclusively.

Write for sample and proofs.

Main Belting Co.

1217-1237 Carpenter St.	Philadelphia
55-57 Market St.	Chicago
120 Pearl St.	Boston
40 Pearl St.	Buffalo
309 Broadway	New York

Metal Polish

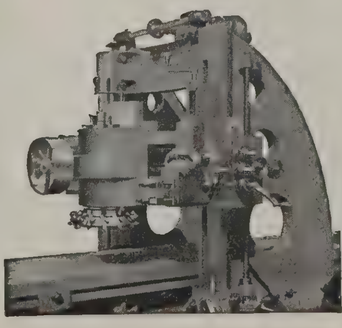
Highest Award
Chicago World's Fair, 1893.
Louisiana Purchase Exposition, St. Louis, 1904.

3-oz. Box for 10 cent.

Sold by Agents and Dealers all over the world. Ask or write for FREE samples

5-lb. Pails, $1.00.

GEO. W. HOFFMAN
Expert Polish Maker,
Indianapolis, Indiana.



Milling Machine

The Farwell Miller, built for Planers, will convert any planer into a combination tool on which milling, boring and planing can be done and at one setting of the work.

Means are provided for vertical, horizontal and angular positions of spindle.

It is built in four sizes.

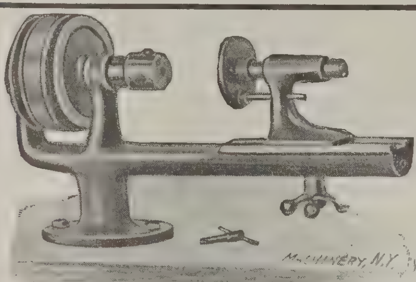
Send for Catalogue No. 55.

THE ADAMS COMPANY
Dubuque, Iowa, U. S. A.

Babbitt-Metals

FOR ALL PURPOSES

Buffalo **LUMEN BEARING COMPANY** Toronto

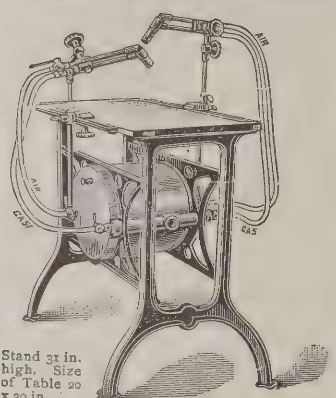


The Champion Tapping Machine

Beats them all for light high speed tapping. Taps holes either through or to depth. Capacity up to ¼″ holes; automatic and rapid in operation—saves the taps.

Sent on approval—write to-day

Blair Tool and Machine Works
24 West Street, NEW YORK CITY



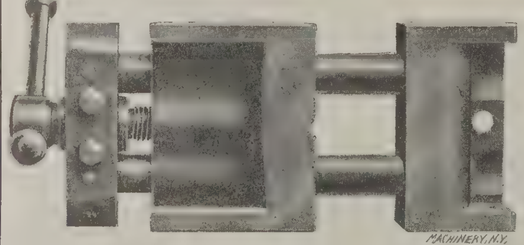
Stand 31 in. high. Size of Table 20 x 30 in.

CLEAN AND QUICK METHOD OF BRAZING

B. D. M. CO'S No. 101 GAS BRAZING STAND for tool room or manufacturing purposes, has two powerful gas blow pipes or burners adjustable in any direction. The substantial iron frame work carries also an air drum and necessary gas connections as illustrated. Equally effective for a small piece of soldering or for a heavy job of brazing requiring both blow-pipes and a built-up fire brick backing. Price, **$35.00.** Catalogue "B.M." to be had for the asking tells more about it.

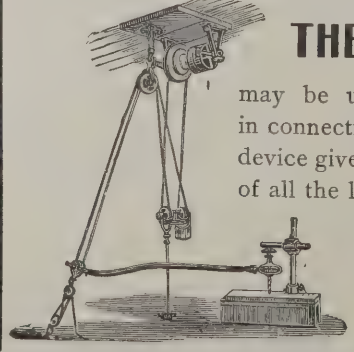
Buffalo Dental Mfg. Company
BUFFALO, N. Y., U. S. A.

THE CONVENIENCE AND ECONOMY OF THE TITUS DRILL-PRESS VISE



was thoroughly proven in our own shop before it was put on the market. It is especially valuable for holding light or irregular work for drilling, one jaw is grooved so that round pieces can be held securely. Guide rods are tool steel, hardened—jaws five inches wide. Thirty days' trial is a reasonable proposition—Shall we send a Vise?

TITUS MACHINE WORKS, Marion, Ohio

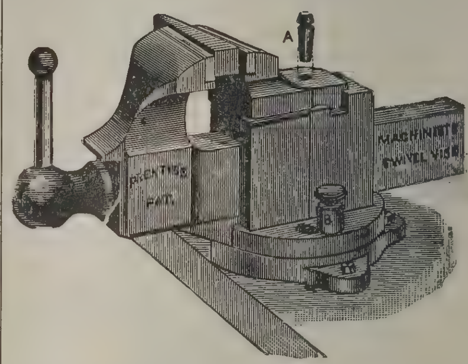


THE STOW FLEXIBLE SHAFT

may be used where electric power is not available, in connection with a rope drive as shown in cut. This device gives a large radius of action; and permits the use of all the labor saving machinery shown in our catalog. For drilling, reaming, tapping, grinding, polishing, etc., it is a shop necessity.

CATALOG ON REQUEST

STOW FLEXIBLE SHAFT CO., Philadelphia, Pa.

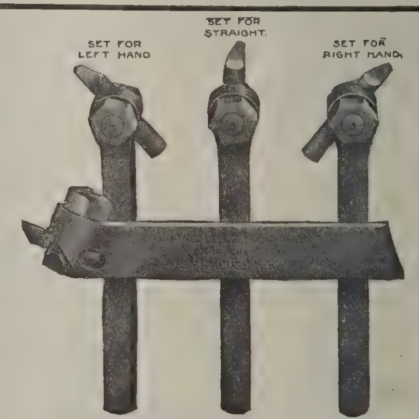


Machinists' Swivel Vise

with self-adjusting jaw that is as strong and durable as any solid jaw, and a Swivel Bottom that gives any desired adjustment to right or left, and is solid and firm at any angle. We make all sorts of good vises, and have been leaders in this line for twenty years. Send for catalogue and price list.

Prentiss Vise Company,
44 Barclay Street, New York.

Agents for Great Britain, Chas. Neat & Co., 112 Queen Victoria St., London, E. C.



Pat. Feb. 2, 1904

CARR TOOL HOLDERS

Model A Square Cutters — THREE IN ONE — Model B Round Cutters

Right and left off-set and straight. Best steel, drop forged and case hardened. Write for prices.

CARR BROTHERS, Syracuse, N. Y.

The Elgin Tool Works

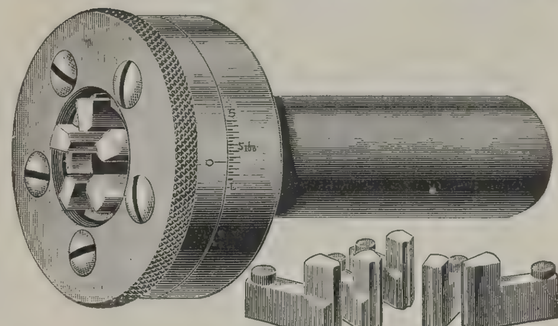
BUILDERS OF

Light, High Grade Machinery and Tools.
Watch Machinery a Specialty

ELGIN, - ILLINOIS

The Economy in Brass Finishing

To be secured by the use of this Adjustable Hollow Milling Tool is well worth consideration. No other device will so rapidly produce accurate, uniform diameters. It is made in various sizes and can be used on any Automatic Screw Machine, Hand Turret Lathe, or Rotated in any way desired. The index permits rapid setting to any diameter within its capacity, and equally quick change from one diameter to another. It will reduce work of any length, will mill close to a shoulder, and as sharpening of blades is done only at the outer edges there is very little time lost in re-grinding.



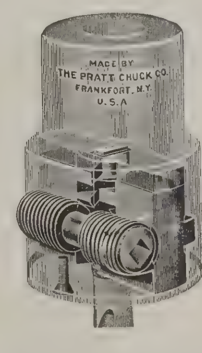
If you are finishing brass work of any kind you will be interested in a full description of this tool. Circulars mailed free.

THE GEOMETRIC TOOL CO., Westville Station **New Haven, Conn., U.S.A.**

FOREIGN AGENTS—Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Glasgow, Newcastle-on-Tyne. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao. Schuchardt & Schutte, Vienna, St. Petersburg, Stockholm, Berlin.

You Need the Pratt Chuck

For high-speed drilling—or for any class of drilling you may have in hand. The time saving, tool saving, trouble saving qualities of the Pratt Chuck count for a great deal when competition is close and the margin for profit small. It holds the drill or tap so firmly that there is no chance of slipping or working loose, it insures quick and accurate work, it does not injure the shank of the tool. Nothing to get out of order—simple and strong in construction. Let us tell you about it.



The Pratt Chuck Company, Frankfort, N.Y.

EUROPEAN AGENTS: Selig, Sonnenthal & Co., 85 Queen Victoria St., London, England.

Don't Stop the Machine

to change the drill, reamer, tap or counterbore—that's a waste of time and a needless labor.

The "MAGIC" Chucks and Collets

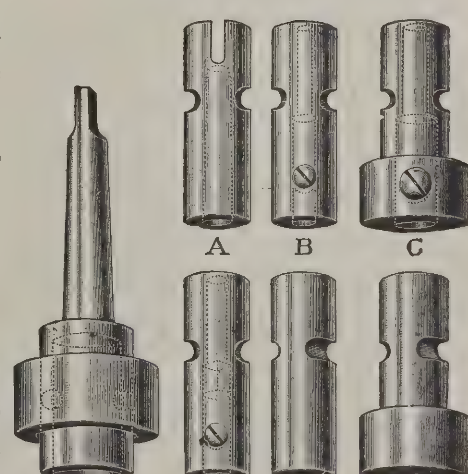
permit the substitution of one tool for another instantly, simply and without lessening the speed of machine. Designed for use on the spindle of upright drills but applicable to lathes or other horizontal spindle tools.

A word from you and we will fully explain the "Magic."

AGENTS: The Prentiss Tool and Supply Co., 115 Liberty St., New York. Frank H. Czarniecki Co., 335 Fifth Ave., Pittsburgh, Pa. O. P. Packard Machinery Co., 34 So. Canal St., Chicago, Ill., Milwaukee, Wis. Chandler & Farquhar, 34 Federal St., Boston, Mass. C. W. Burton, Griffiths & Co., London, Eng. J. Lambercier & Co., Geneva, Switzerland.

Modern Tool Company

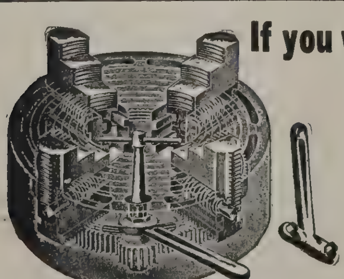
Erie, Pa.



A B C

CHUCK D E F

If you want the best Lathe and Drill Chucks—buy Westcott's



Spur Geared Scroll Combination Lathe Chuck.

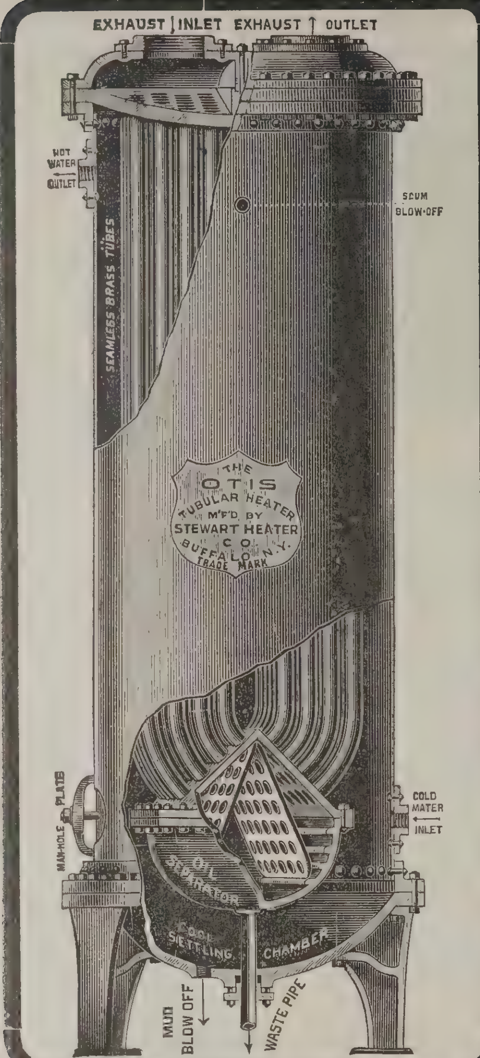
Little Giant Auxiliary Screw Drill Chucks, Little Giant Double Grip Drill Chucks, Little Giant Improved Drill Chucks, Oneida Drill Chucks, Spur Geared Scroll Combination Lathe Chucks, Scroll Combination Lathe Chucks, Geared Combination Lathe Chucks, Geared Universal Lathe Chucks, Spur Geared Scroll Universal Lathe Chucks, IXL Independent Lathe Chucks, Cutting-off Chucks.

Strongest Grip, Greatest Capacity,
Great Durability, Accurate.

WESTCOTT CHUCK CO., Oneida, N.Y., U.S.A.

Ask for catalogue in English, French, Spanish or German.

Little Giant Auxiliary Screw Drill Chuck.



THE OTIS

Tubular Feed Water Heater, Oil Separator and Purifier

is not an experiment but a tried and trusted appliance that the makers are not afraid to

GUARANTEE

To heat the feed water to the *boiling point* (210 to 212 degrees) with the exhaust steam without causing any back pressure, *also to extract the oil from the exhaust*, so that the exhaust steam after being passed through the heater can be used for heating purposes, and the water of condensation for the heating system be returned to the boiler without the *additional expense* of an *eliminator*.

We are so sure of the OTIS that we agree to pay all cost of a trial—freight, cartage, piping, etc.—if it fails to do all we claim for it.

Catalogue and Prices at Your Service

The Stewart Heater Company

79-99 East Delevan Ave., BUFFALO, N. Y.

POOLE ENGINEERING & MACHINE CO.
ENGINEERS, FOUNDERS AND MACHINISTS.
BALTIMORE, MD.
MANUFACTURERS AND DESIGNERS OF ALL KINDS OF
HEAVY MACHINERY,
REQUIRING FIRST CLASS WORKMASHIP AND MATERIALS.
BAND, ROPE AND FLY WHEELS. FRICTION CLUTCHES, SHAFTING, PULLEYS AND HANGERS.
MACHINE MOLDED AND PLANED GEARING.
MACHINERY for WHITE LEAD and FERTILIZER WORKS,
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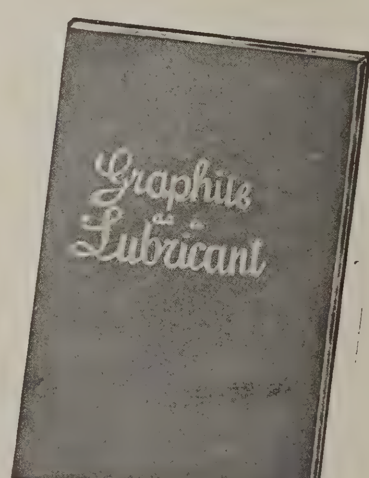

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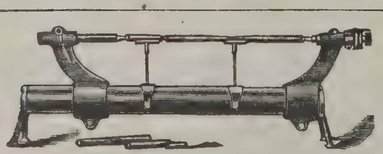

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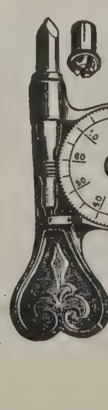

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We build Air Compressors with capacities ranging from 1 to 100 cubic feet free air per minute.

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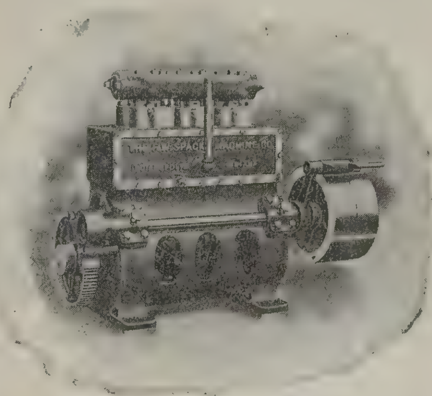

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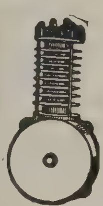

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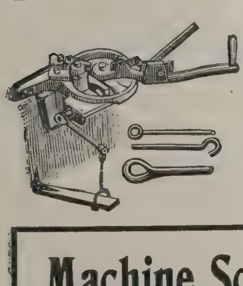

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We make hand power benders for forming eyes from stock 1 3-8 inch thick and under. Any size eye 7 inches outside diameter and under.

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Quality Accuracy Guaranteed

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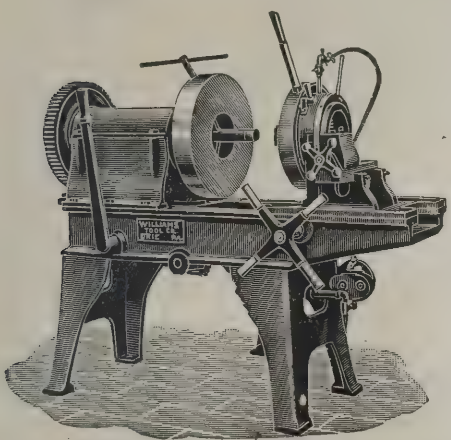

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Newly designed, strong construction, rapid and convenient in operation. Quick opening and adjustable dies. Six speed changes without shifting a gear.

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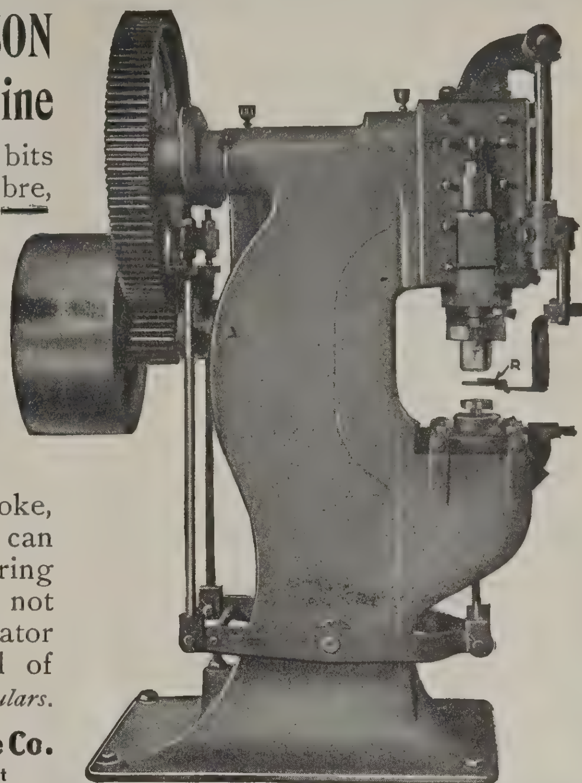

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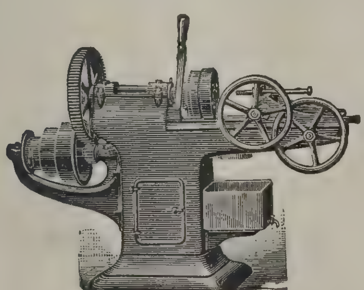
Bolts are all the same size and equally well finished.



This machine is distinguished by the very simple construction of the Head—which has but four parts—its durability and the few repairs needed. The square bearing of the dies in the ring gives them all the advantages of solid dies. The Merriman machine is very rapid and can be run by an unskilled operator.

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THE H. B. BROWN COMPANY
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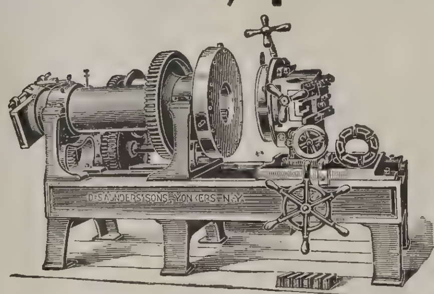
As nearly perfect as can be made



is what we claim for our

Pipe Threading and Cutting Machinery

These machines are the result of forty years' practical experience in this line of manufacture, and are unsurpassed for efficiency of operation and quality of workmanship.
May we send you our catalogue?

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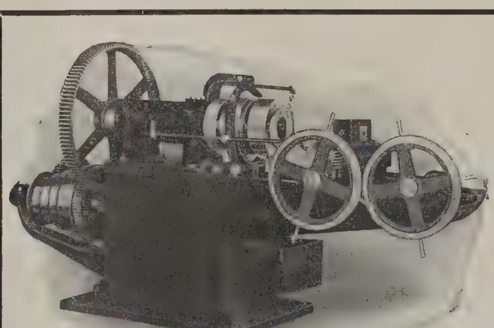

You Can Double Your Capacity

For Threading and Cutting Bolts by Installing

STANDARD BOLT CUTTERS

The Standard Head is unequalled for simplicity, durability and accurate product; the dies are adjustable and easily set to cut over or under size; threads cut are equal to lathe work, and once started a Standard Bolt Cutter looks after itself.

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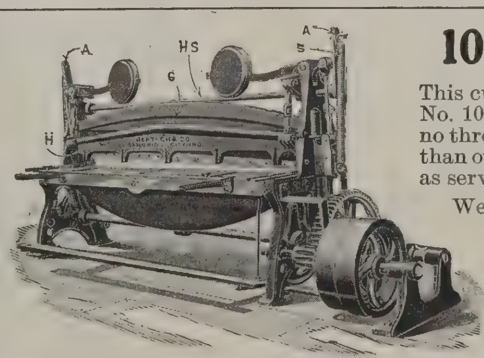

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This cut shows our No. 0 Shear built for No. 10 gauge sheets. Note that it has no throat, hence it is lighter and cheaper than our regular Mill Shear, but it is just as serviceable for some classes of work.

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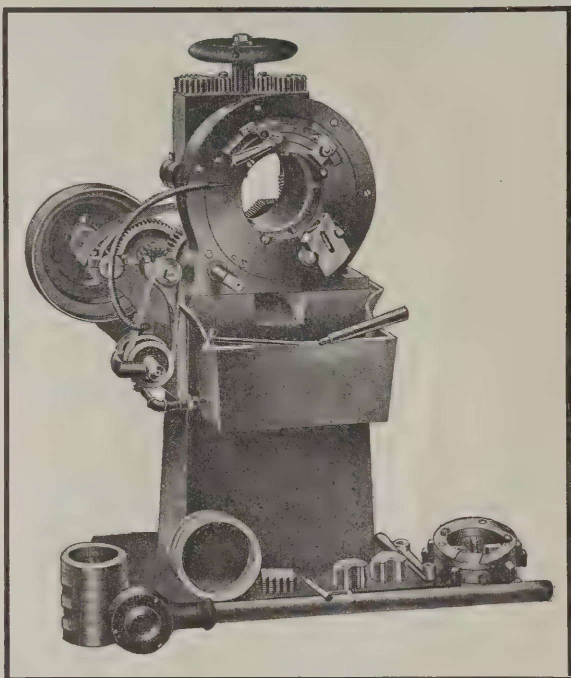

WE say—any Merrell Pipe Threading and Cutting Machine turned out of this shop will not only *equal*—but *better*—the record of *any* other pipe threading and cutting machine ever built.

And we'll ship this Merrell, anywhere, for 30 days free trial to prove it.

Now do *your* part.

This Combination Hand and Power, Portable or Stationary Merrell is the only machine made that will cut and thread satisfactorily, 10 and 12 inch pipe when in use as a hand machine.

It operates simply, easily and economically—and it *always* operates—without hitch, or break-down.

Cuts any style or pitch of thread, and any size or kind of pipe up to 12 inches.

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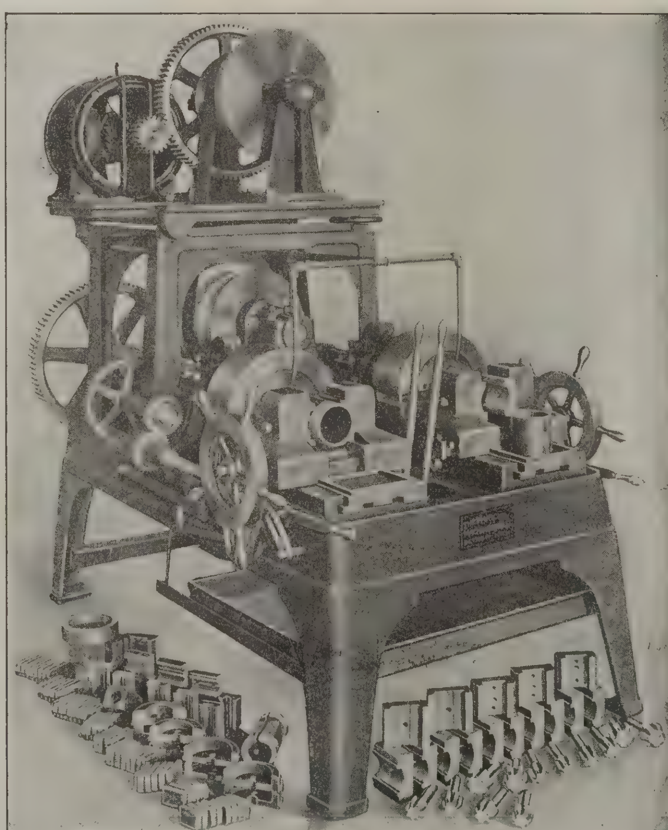
Murchey Double Head Nipple and Pipe Threading Machine

MOTOR DRIVE

LEAD SCREW ATTACHMENT

NEW STYLE DIE HEADS



These machines are four times as rapid as the old style pipe machines and the most efficient and convenient tools of their class.

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